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AUTHOR Marsh, Norman F.
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ABSTRACT

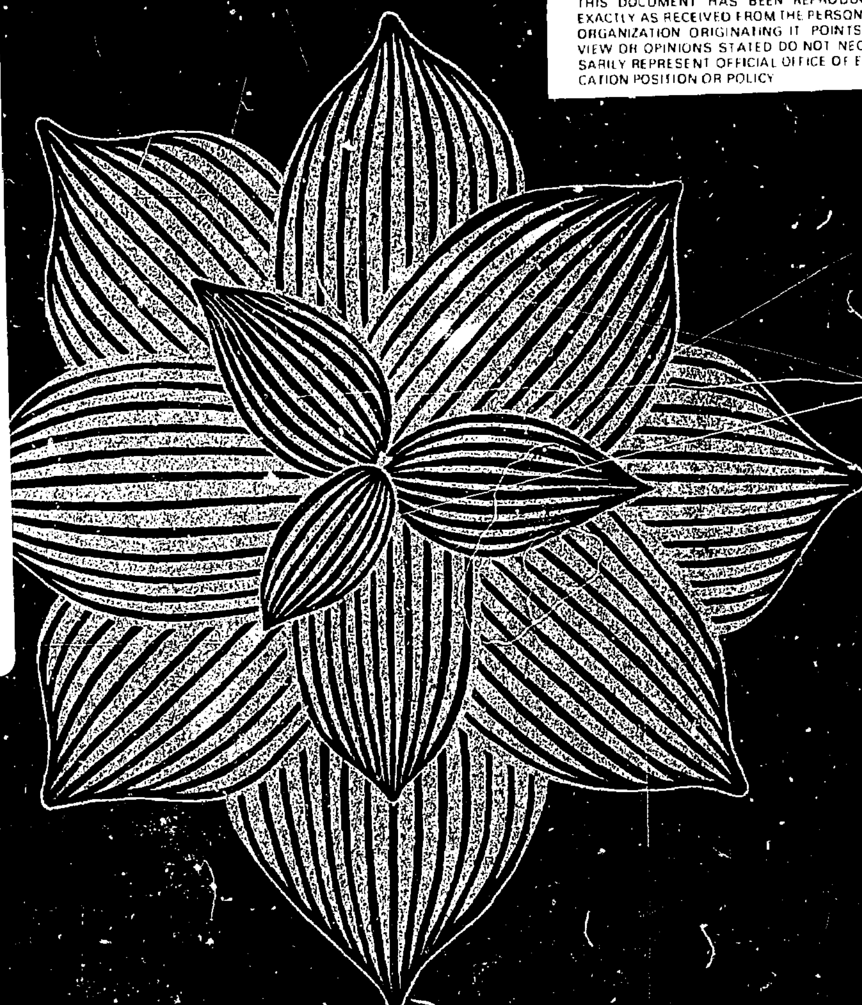
The use of school grounds as an outdoor learning area is the main emphasis of this manual for elementary and junior high school teachers. Detailed plannin g steps, site plots, directions for planting, and other related planning information are given, along with guidelines concerning the use of an outdoor classroom by teachers of various subjects. Instructional study areas for which learning activities are described include birds, weather, insects, soil, plants, water and water life, mathematics, photography, language arts, and arts. Specific concepts relating to ecology are also presented as examples of possible utilization of an outdoor learning area. Pictures, diagrams, and suggested materials are provided. (AL)

Outdoor Education on YOUR School Grounds

An action approach to better teaching

By Norman F. Marsh

A Manual for Elementary and Junior High School Teachers



ABOUT THE AUTHOR . . .

Born in Bangor, Maine, Norman Marsh grew up in or always near the outdoors in a state famous for its natural settings.

Before World War II he worked as a transit operator on a surveying project for the Civilian Conservation Corps in Acadia National Park.

Moving to Hartford, Conn., he became a district sales training manager for the Atlantic Refining Co. Later, Pratt-Whitney Aircraft Corp. hired him as a production expediter, a position he held until enlisting as an Aviation Cadet in the then Army Air Corps.

During World War II he served as a navigator in Flying Fortresses with the Eighth Air Force. He was awarded the Distinguished Flying Cross and five Air Medals.

Towards the end of the war he was employed at the Atlantic Overseas Air Technical Service Command, Newark, N. J., as Assistant Base Engineer.

After the war, he transferred to the U. S. Army Engineers as Battalion Personnel Officer, Fort Belvoir, Va.

Returning to the newly created U. S. Air Force, Mr. Marsh served as senior navigation instructor for pilot trainees in Texas and Oklahoma and for navigation refresher courses at Mather Air Force Base, where he wrote the ground training courses for advanced navigator trainees.

His higher education began at the University of Maine in 1938–39, was interrupted during the war and immediate post-war years, and concluded at Sacramento State College in 1951, where he graduated in a net total of 2½ years thanks to credits granted for prior experiences and in-lieu testing.

Mr. Marsh holds California Dept. of Education credentials in Elementary Administration, Elementary Teaching, Junior High School Teaching, and Adult Education Teaching in Conservation of Natural Resources. The latter three credentials are Life Diplomas.

For the past 16 years he has taught 5th and 6th grades in the Sacramento City Unified School District, emphasizing science and mathematics. For four summers he taught 6th grade science in the Summer Demonstration School sponsored by Sacramento State College and, for two summers, 6th grade mathematics. President of the Sacramento Regional Science Teachers Association and active in local conservation activities, he finds time once a year as chairman of the judges of the annual Central Valley Science Fair and as often as he can indulges in color slide photography, especially nature photography.

Mr. Marsh lectures frequently on outdoor education topics and has written several articles on this topic. Occasionally he serves as consultant to the State Dept. of Education.

The planning and developing of the Bowling Green Arboretum in Sacramento since 1962 opened new vistas for him. It was from these recent experiences that this book has evolved in response to requests for information on the topics herein.

The State of California is pleased to publish this guidebook as an assist to conservation education.

EDWARD F. DOLDER, Chief
Office of Conservation Education
Resources Agency of California

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ACKNOWLEDGMENTS . . .

To Robert J. Bone, principal of Bowling Green Elementary School . . . for having originally raised the question of using the school grounds for outdoor education of some sort . . . and for having the wisdom to let me pursue the planning and developing in my own way . . . and for successfully skirmishing the administrative confrontations that we encountered along the way. Without his faith in me and his positiveness in times of frustration, quite possibly the Arboretum never would have amounted to what it is today.

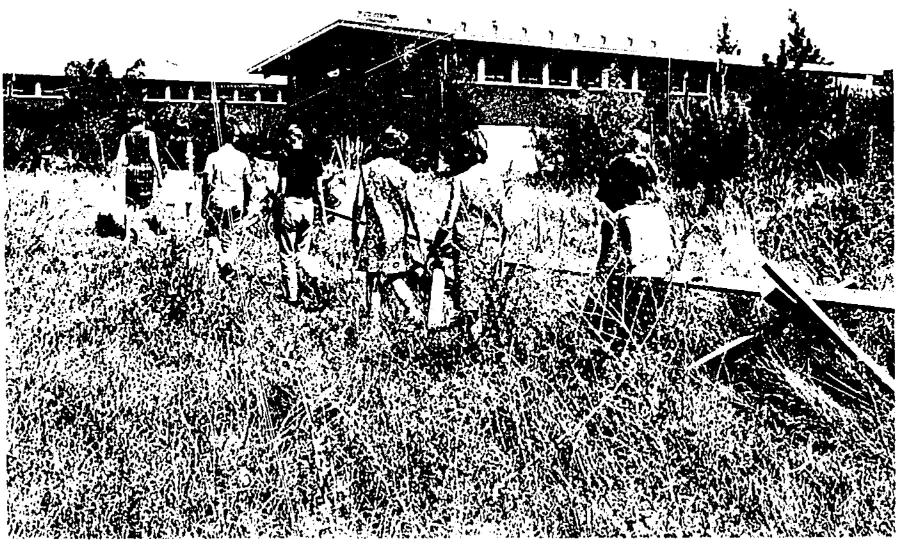
To Charlotte Doyal, primary teacher at Bowling Green, who had the courage to try out some of these innovative approaches to new learnings . . . and who contributed, as a result of her experiences, some of the primary observation activities herein . . . thus paving the way for a few other teachers to make the effort.

To John Bailey, Special Materials teacher at Sacramento Senior High School, who was concerned enough about reaching his academically deficient students in ways that would be more productive . . . and thus spent weekly hours after school with me exploring these avenues.

To my wife, Virginia, and our children who so patiently endured (or became resigned to) my many absences and pre-occupations away from the family circle while planning and developing both the Arboretum project and this book.

To the many, many boys and girls who, in many ways, made it all worth while.

Norman F. Marsh Dec. 21/67



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Surprises by the Master Creator await those who will see, and listen, and smell.

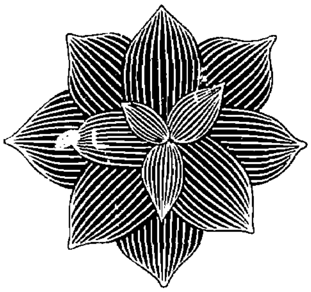
WHAT *IS* OUTDOOR EDUCATION?????

Outdoor education is simply learning out-of-doors those facts, themes, and concepts that can *best* be learned outside the traditional classroom. This leaves to the *in*door classrooms those matters best learned in the *in*door settings.

Outdoor education embraces primarily all the life and physical sciences plus understandings of the total environment of man in natural and in man-made surroundings. Closely inter-related are the expressives of the language arts, the aesthetics of music, the style, forms, and perceptions of art, and the preciseness and quantitative aspects of mathematics.

Outdoor education may be approached by means of (1) Field Study-Trips (usually up to one day's visitation and activities), (2) a week-long stay at a Resident Outdoor School, (3) effective learning programs on the school grounds, and/or combinations of these three.

It is the third consideration that constitutes the purpose and scope of this manual for teachers.



WHY SHOULD *YOUR* SCHOOL HAVE AN OUTDOOR LEARNING LABORATORY???

Teachers daily round up boys and girls, herd them into an enclosure of four walls and surrounded with a chain-link fence. They then proceed with the 'help' of various models, devices, and words, and by equally devious methods, to 'study' and talk about those otherwise interesting things that exist and go on *out*side the classroom!

Admittedly, many things can not be observed or learned about except by reading or viewing films. Cost factors and other practical barriers stand in the way of first-hand experiences in *every*thing. The point to make here is that we overemphasize *in*door learning when *many* times the available out-of-the-classroom potentials offer opportunities that surpass indoor study.

No teacher is creative enough, resourceful enough, patient enough, or financially able to duplicate or re-create indoors the real, on-going fascinations that have always existed in the outside world.

Somewhere in these continual struggles to simulate (and stimulate)—in these artificial, synthetic, and contrived settings—the learning processes lose their VITALITY.

Some of the milder penalties for 'make believe', for Mickey Mouse contrivances, for continually reading about someone else's experiences and duplicating his well-known and proven lab exercises, is *boredom,* which later leads to *frustrations,* and you teachers well know the symptoms and by-products!

When teachers demand conformity and equal achievements from an internal situation such as described above, natural curiosity becomes blunted and eventually non-existent. The compliant will adapt to the realization that it does not pay to ask questions that interest *him*, but that it makes for better relations to supply on demand the answers that the teacher wants to the questions the *teacher* thinks are important. The excitement of experiencing creative thinking is thus thwarted. Curiosity is murdered. Rigor mortis sets in.

A WAY OUT OF A DILEMMA . . . Outdoor education offers sustenance and vitality to any program, especially in the sciences—life, physical, and social.

Here, for example, on the school grounds, a student can observe real plants, real clouds, real insects, real birds. From genesis to exodus! Their pattern is ever-changing—an open book—a revealing library—inter-related and ever changing. Now the child can explore, investigate, analyze, and make inferences that to *him* are meaningful. That is, he can become involved via activity, participation—a Direct Experience Approach to Learning. He has received a good D.E.A.L.—*and* he didn't have to copy it off the chalkboard, fill in the blanks on a ditto busy-sheet, or listen to someone talk about it. The teacher didn't have to write it out on the chalkboard, prepare and hand out the ditto, set up projector and screen, or overuse her voice (to which most students become quite adept and subtle at tuning out). All they had to do was walk out the door and there it was!

THE NEW DEAL goes into effect as soon as boys and girls:

> are given an opportunity to periodically leave the indoor classroom and start looking around outside.
>
> see the teacher demonstrate vision, inquisitiveness, and willingness to try new approaches to satisfying curiosities.
>
> help the teacher generate some outdoor activities that will guide them into innovative challenges.
>
> realize that their teacher is open-minded, not time-bound . . . and will take the time to listen in an encouraging manner to those important matters children so often have on their minds.

Some introspection at this stage tells us whether we have been contributing to the problem or to the solution! Our *awareness*, translated into *concern*, leads us to the next step in grappling with outdoor education on our own school grounds. . . .

Decision Making . . . Before deciding whether or not to embark on an outdoor approach as a new way of school life, you, the teacher—the molder of many persons and personalities—should inventory your own reactions to these thoughts, these concepts, these attitudes. . . .

> **Do you believe** . . . That any generation can own a resource only temporarily? That generations to come also own it temporarily, and that their welfare will depend on the state of the resource when it is delivered into their hands???
>
> That all human activities and institutions have their bases in and are dependent upon natural resources? That all creations in the laboratory are but rearrangement of the molecules of matter which originated from the natural world . . . air, water, land, plant, and animal life???
>
> That increasingly high-density urban areas tend to produce tensions, anxieties, neuroses, and psychoses . . . because we are losing intimate contact with our natural heritage, the good earth???
>
> **Do you care** . . . That 'planned obsolescence' in industry and sales promotions is a social and economic disease rapidly, surely, and unnecessarily devouring our non-renewable resources???

About the rapidly increasing costs of an expanding wreck-reation —recreation without understanding, without appreciation, without concern???

Do you realize . . . That EDUCATION—effective and continual—is the main (maybe the sole) answer to correcting the environmental abuses of the past and laying solid foundations for lasting desirable attitudes and actions for future management of all natural resources for the good of us all???

That an opportunity must be created for ideas, facts, relationships, stories, histories, possibilities, artistry in words, in sounds, in form and color . . . that these may crowd into the students' life, to stir his feelings, to excite his appreciations, and incite his impulses to live harmoniously in his whole environment???

If you, the teacher, have read *this* far, you probably *care* about what goes on in the teaching-learning situations. You are probably an embryonic or a practicing *creative teacher*. You continually work at:

Developing the skill of respecting the child's questions and ideas.

Asking provocative questions.

Recognizing and valuing originality.

Accurately predicting behavior.

Seeking the truth—and change your mind and behavior when new evidence 'is in'.

Lessening the boredoms, the frustrations, the damaging effects of continual failure, the dulling of initiative, the stagnations of rigid conformity to expedients.

YOUR DECISION . . . If, at this point, you definitely are not interested in rocking your own boat, or are already doing an outstanding job, then don't read any further. Lots of luck . . .

If you are 'with us', then you won't mind a few more thoughts on the values of outdoor education in general. If you could use a little more encouragement, or fortification of your hopes for a better life, then read the next few pages, at least, and get your local administrator to do the same.

The outdoor laboratory is an extension of the indoor classroom. Outside, the pressures can be off as in few other ways. Here is a sanctuary, a chance for a spot in the sun for the less academically talented. Here is a challenge for the unstructured mind to explore, gather information, and arrange a new order, a new structure of meaning and interest, where success is not guaranteed, but you can work at it.

From a good outdoor education program emerges a reaffirmation of the insight that there is only one subject matter for education, and that is LIFE, life in all its manifestations! Skills, information, knowledge—all must be used if they are to have meaning for the student, if they are to be retained, and if they are to have any relationship at all to Wisdom.

Frank McIntyre, Information Services Executive for California Teachers Association, says that children today must "interrupt" their education in order to attend school. "Things happen much faster outside the classroom than inside, so we must bring the outside inside." Which is another way of saying we need a lot of up-dating of our offerings in schools and some new approaches.

It has been said that, "It should be the chief aim of the teacher to exhibit himself in his own true character—that is, as an ignorant man whose thoughts and activities utilize his small share of knowledge and through induction and deduction seeks to extend it."

In such a setting, both intellectual and physical enjoyment, often artificially separated, could be re-united—and this is very important, because thought becomes impotent as it is divorced from action. Here both teachers and pupils could rediscover the worth and value of their association in the common enterprise of purposeful learning. To a large extent, this is the concern of youth today. They are searching for involvement—for the opportunities to throw the concepts, facts, and information they acquire into all possible combinations, and to test the immediate events of their lives as instances of their general ideas.

In a stimulating physical setting, where there is an opportunity for individual participation and involvement, the vividness and romance of subject matter can be restored—whether the focus of attention is historical, biological, ecological, artistic, or political.

Outdoor education calls for alert, imaginative, creative and bold teachers, PLUS a setting, an opportunity to enrich and extend oneself. In life, we pass this way but once.

Why should your school have an outdoor learning laboratory? You know why. Because there are lots of 'customers' already signed up, and because there are a few people like you around to make it all come to pass.

THE SCHOOL GROUNDS AS AN EXTENSION OF THE INDOOR CLASSROOMS

All techniques presented concerning Planning, Developing, and Using the school grounds for learnings are proven, field tested and quite vital to the total success. It is important that the Planner become *involved* personally in the researching and mechanics. No package deal, no instant-success kit will be available nor should it be so.

PLANNING THE SITE . . . The author is going to assume that the reader is not content to use the existing facilities 'as is'; that he probably already has given the matter some thought anyway; that he prefers to develop present facilities into some sort of a 'natural' area for outdoor learnings.

The following is the outline of the master plan by which the Bowling Green Arboretum and Nature Center was processed and came into being in Sacramento, California:

Tree planting begins down deep

MASTER PLAN—SCHOOL OUTDOOR NATURE CENTER

I *Selecting the Site.* Considerations.

II *Planning and Developing the Site.* Sequential steps toward fulfillment.

III *Developing the Planting Plan and Chart.* Considerations for plant selection and location within the Nature Center.

IV *The Plan for the Actual Planting Projects.* Labor, tools, etc. "Who", "When".

V *The Maintenance Project, a Plan for.* Summer, vacations, school days.

VI *Plan for Educational Utilization of Center.* Detailed outline of proposed teaching-learning activities and anticipated outcomes.

VII *Formal Presentation of Master Plan* (I to VI) to local admin., P.T.A., etc.

VIII *Formal Presentation of Master Plan* (I to VII) to District Admin. and District Board of Education. Include results of VII above.

IX Either abandon entire Master Plan (Note . . . You're in the wrong district!)
or
Proceed with actuating III, then II, then IV, etc. (Preferred route)

Plan . . . to keep records during the various stages of development and planning.

Plan . . . to have, continue, and use educationally a colored slide history of the entire project—from pre-embryo on and on. (open end)

Profiting from the experiences gained in developing the Bowling Green site, and advising others in getting off to a good start and following through, results in a storehouse of little particulars that mean the difference between success and abandonment.

In *Selecting the School Site, where to start* depends on present land space available for site improvements and land management.

Most schools, especially those in suburban areas, have *rectangular, grassy plots* between classroom wings. These areas are ideal for many reasons. They are close at hand, thus affording easy and rapid access and ease of supervision when not in use as a classroom. These plots are also viewed by many throughout the day (albeit in an incidental way). Piped water is usually available and maybe a drain in the low spots. These factors cut down on costs of site improvement and subsequent maintenance. The same space usually is only grassed, watered, and mowed with or without a few unimaginative plantings here and there. Educationally speaking, these portions of the school grounds offer no educational opportunities as they currently exist, yet the district has invested money and continues to maintain such white elephants.

In addition to the possibilities offered by the rectangular interclass plots, there often is a larger, more remote section of the play area that could be used educationally.

Genesis of a Nature Area—an unused rectangular plot next to Science room becomes the site of first plantings.

Out went an unused portable classroom—in went an outdoor conference site.

Some school persons desire that the nature center start *near* a classroom (usually a science room), then expand away towards *a more* remote section.

The 'farther away' site tends to give the impression of 'away from it all', a slightly more 'wild' atmosphere . . . albeit less likely to be used in inclement weather.

Once the decision has been made as to closeness to the classroom or a more remote plot, then *a large sketch* of the proposed site should be made. Measurements or paces of the periphery should be taken and scale-drawn onto the large drawing, to be referred to as *The Plot Plan*. Incidentally, try not to outline the plot with straight lines. Large curved boundaries with identations and peninsulas are more effective, naturally speaking.

Planning of any phases to follow may be done by a committee of one or of a working committee of as few persons as possible to get the job done. Do not ask for volunteers. Select persons who you know possess certain talents and experiences that would make them productive committee members. This is VERY important! Ask only these persons to serve on this project.

If the advice or assistance of other persons is received from time to time, fine. Such aid can be accepted or rejected for the specific instance. You are not stuck with an inept and undependable committee member for the rest of the planning. Educators are too prone to committee things to death. Be careful!

The next item for planning consideration is the making of a *list of sub-plot areas* to be included as portions of the overall plot. If at least one

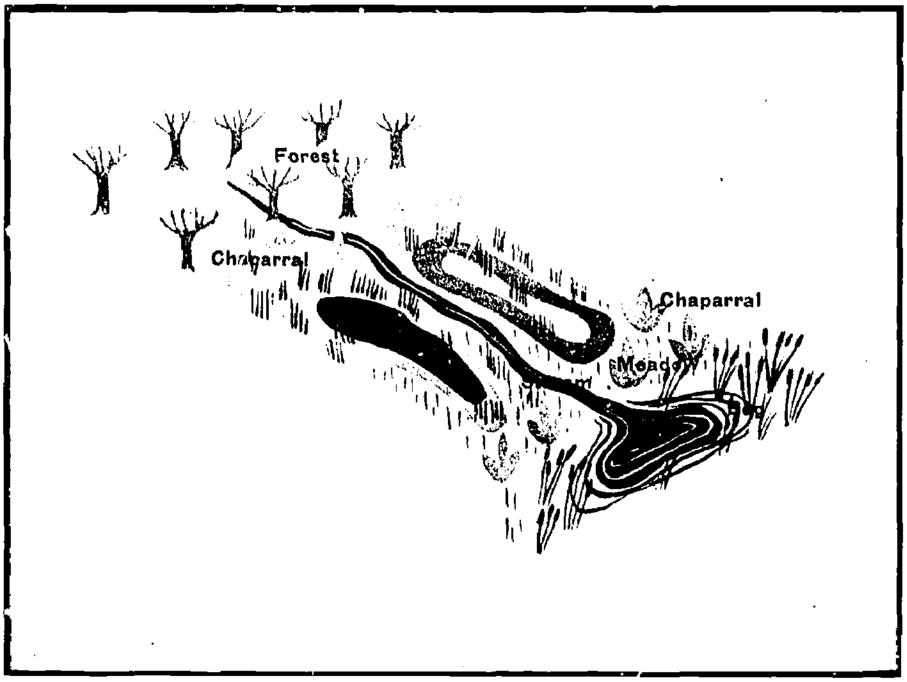
This "forest" began nine feet deep in the ground. Drainage plus broken tile plus mulch equals headstart!

acre can be planned for, try to *include a meadow* with a *stream* running through it into a *bog*. Border the meadow with a *chaparral* belt which merges into a *coniferous forest*. Transitional plantings marginal to each will be planned later.

During the rainy season is a good time to observe where most surface water seems to collect. Otherwise, lay down a hose near where it is anticipated that the stream will start. Let the water flow for several hours. The path it takes will indicate where to cut out the banks of the stream later. Also, you will be able to see where the bog would naturally be located.

Now, on the Plot Plan you can *rough in the probable boundaries* of the meadow, with the course of the stream. Continue to rough-in other sub-plots. Consider the presence of higher mounds or plateaus of land. Think of the actual meadow, chaparral, and forest areas you have seen, or look at some pictures of such. Note details of marginal shapes and topography. Try to simulate this naturalness on your school site. If the school is situated in the chaparral belt or in the forest, then most of these considerations are already taken care of for you.

Your modified school grounds might begin to look like this (on paper)



The *general topography* of the land will need to be considered. The boundaries of the meadow should be slightly higher in elevation than the bog, to assure movement of stream water.

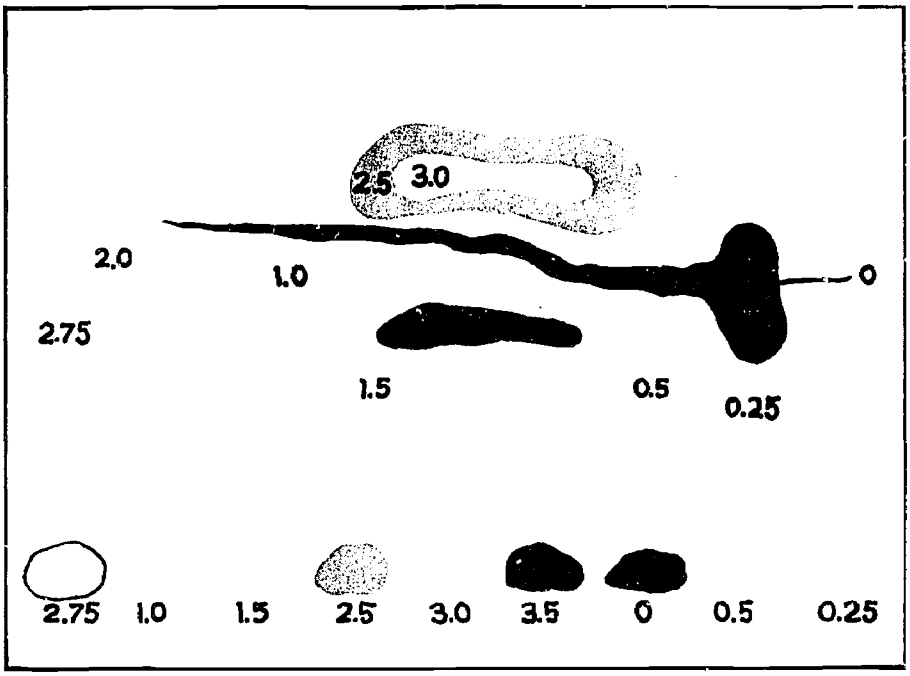
The chaparral belt should be the land slightly up-sloping from the meadow. The higher wooded area should extend down to the irregular margin of the chaparral. These factors simulate the naturalness of the vegetation belts in general.

Many school sites are very flat with hardly any change in topography. The Bowling Green Arboretum, in Sacramento, is a living example of what can be done to a piece of former pasture land. All the above mentioned subplots are incorporated on a one acre site. The developed area starts in a wing between classrooms and moves outward to serve as a natural divider between primary and upper grade playgrounds.

Topography can be altered somewhat, especially if land appears too flat. Importation of soils and fill material can be mounded as islands and peninsulas of earth for plantings. This is especially desirable, not only for the aesthetics of appearance, but also to assure good drainage. It is hoped that the planner(s) would want to incorporate as many native California plants as possible. Native plants require good drainage. The native habitat of each will indicate to you the watering requirements of each. The research into this phase of your planning will more than reward you with many interesting tid-bits of information about the uniqueness of each variety.

Mounds also tend to break the monotony of the sameness of flat land. The changing views, as one walks along the winding trails, make a walk much more interesting. Whether mounds are constructed or already present, it's a good idea to make a plot plan showing differences in elevations of major areas. This can be done by a high school surveying class (which makes an excellent project for them also) or you may make a pretty good sketch from eye or by using less sophisticated but useful instruments. The *activity section* of this book may be of help to you in putting direct-experience math to work for you.

Now the Plot Plan may look something like this . . .



The figures on the contours are in reference to the lowest elevation (bog). Changes in elevation need only be a few inches and feet to be quite effective with proper plantings.

If the site is blessed with land already contoured and sculptured for you, so much the better. Just put the natural assets to work for you.

While the Plot Plan is still being considered, make a few last checks to see if the approximate extent of each sub-plot is really what you would like to see eventually, when planted. Try to visualize the spots with plantings, trails, benches. This is just day-dreaming, but it will pay off later—and you are beginning to get the feel of things. Now, be Bold and Decisive! Draw in the finalized boundaries. This is the beginning of your *Plant Plan*. Stick to it, and any subsequently finalized stagings. Don't make changes unless later evidence forces you to do so. Vacillation has stalled many a similar project. So stick to your mission and plans after they have been researched and finalized . . . from here on.

You are now ready to research just *what plants are to be planted just where!* The data gathering for this phase begins with

1. What native plantings are typical of some areas you want to simulate?
2. Which of these typicals will grow in *your* particular climatic conditions?
3. Which of 1 and 2 above are available locally?
4. Which of 1 and 2 are not available locally but can be obtained within a reasonable distance?
5. Which of this now narrowed-down list would be unsuitable due to ultimate size, susceptibility to diseases and/or insects. Cross these off!
6. Which would you like for aesthetic reasons? (Include these, other factors being equal.)
7. Now price each item as best you can. (Figure $1.50 per 1 gallon can size, and $4.95 each for 3–5 gallon can size.)

The Appendix contains listing of plants used by the author in planning the Bowling Green Arboretum, plus fact-sheets deemed helpful from experience. These plants, of course, would be recommended only for similar climates, etc.

After reducing your plant list to those you would like to have because they would naturalize the sub-plots and grow well in your climate and growing conditions, be sure to *make known your plant needs* to local garden clubs, nurseries, and individuals likely to be of some assistance to you. Taking this route has several advantages. As a result of advertising your needs, you also tell people of the educational project in the offing. Soon you will know which plants can be obtained locally and which can be obtained from a nursery or individuals in some other part of the state, and which can not be had within the foreseeable future. Letting others know what plants you need for this project also precludes your having to turn down some well-meaning person who is thinning out his garden and wants to help you by offering something you don't possibly want . . . it's just not in your plans.

When your plant-need list is pretty well finalized, make copies for distribution as mentioned above. Carry a few with you at all times.

Now you are arriving at *two important phases of the overall planning! Administrative approval* must be had! Why wasn't this considered in the beginning? Most administrators are conservative. Something so radically new as your proposal could end up negated just to play it safe . . . *if* you hadn't planned out the details so carefully, making it hard for them to say 'no'. If the whole idea is worth having, then it's worth planning very carefully. And a big part of your planning is how to meet anticipated objections that your administration is likely to pose for you. Up to now all you've invested is your time. And you learned a lot in the process. Success isn't guaranteed, but planning and involvement is worth the effort. Your acquired knowledge and enthusiasm can be contagious. Put these assets to work for you.

One of the first 'posers' your administration will confront you with concerns the source of *Funds*. Again, making it easy for them to say 'yes' is a part of your planning. If you and your principal have previously approached your P.T.A. or similar group (and you should have all along), then money can be forthcoming from this source to acquire plants, etc. Labor is no problem . . . you and the children can supply plenty of that. You probably need the exercise and fresh air, anyway. It's surprising how much can be done in recess, lunch periods, before, and after school moments. A little here and a little there adds up fast . . . and the scene begins to change!

The Bowling Green Arboretum Plan was presented in this manner. The money for the plants was donated by the P.T.A. The author researched and planned the project. The principal, Robert J. Bone, presented the total package to the Assistant Superintendent, and then to the Board of Education. The skids had been greased via planning details. The needed approval was readily granted. It should also be mentioned that a long listing of subject-matter areas that could be utilized in the out-of-doors was included. The Appendix includes this listing for your considerations in your own plannings.

Be not of faint heart! What others have done, so can you . . . and better! You have the benefit of the experiences of others plus your own ingenuity, resourcefulness, and ambition to polish up your planning. The ice has been broken. There are precedents. The way is being paved. Those of us who have experienced the joys and exhilarations of learning via direct involvements outdoors stand ready to help and encourage others.

If, after all your planning, your proposal results in being turned down, a few alternatives await you. Here is the test of just how much you REALLY want this project to come into being!

You can pick up the pieces and go home. Later, hold a post-mortem. Analyze just why you think your presentation was not successful. Discuss this with others. You may gain new insights. Re-plan your proposal (that's right, don't be a quitter) and try again. If turned down again . . . you are working in the wrong school district. If you are still convinced that this is a good idea and must come to pass (for you), then a transfer is in order. This is exactly what certain persons have done when confronted with an intolerable situation, a major frustration, and were willing to make the change.

The author has made many slide talks to school staffs, to P.T.A. meetings, to garden clubs, to administrators only, etc. Many times an administrator has said, "If only I had a teacher or two whom I could get to do something like this!" Many a teacher has said, "If only I could get my principal or district to go along on something like this!" Obviously, the positive-minded should seek and associate with positive-minded persons with the same can-do spirit.

A strong motivating drive is necessary to accomplish anything worthy.

We who would lead the way . . . get out front of the pack . . . should realize that developing and using the school grounds as an extension of the indoor classroom is quite revolutionary to most educators (though certainly not new at all).

Why should something so basically sound and not so awfully difficult to attain be given so much resistance by some educators? Why should inertia be so difficult to overcome? Don't try to figure it out; don't try to fight it unless you are a rugged individual. Just consider yourself fortunate if no large barriers are placed in your path. If you don't associate with positive-minded administrators who have vision and the ability to come to grips with worthy confrontations, such as your proposals, then that's your fault . . . for such administrators do exist. You just haven't crossed paths yet.

If you are faint-hearted about 'getting with' this kind of project, then the rest of this book is not for you.

We are now ready to assume that *Developing the Site* is going to take place. The Plot Plan is pretty well jelled, the plants have been selected (on paper, at least), the sources of the plants have been ascertained, as well as their costs, and the sources of the funds to buy the plants is known.

Get that plant list circulated. Make a 'prospect' list like a good salesman would do. Get the P.T.A. going on this. Most P.T.A.'s *need* something like this once in a while to pull themselves together and add vitality to their programs and activities. They usually welcome the chance to do so.

While the plant-procurement phase is going on, look over your plant list to ascertain when would be a good time to plant certain of these. Consider whether you want to block in a whole sub-plot at once or scatter some plantings in each of the subplots. Check their ultimate size and sketch them in to scale on your Plot Plan. (One inch = 6′ or 8′ is a workable scale.)

Don't worry about all that space in between the first plantings. Plants have a way of growing up and filling in space sooner than you may think. Good planting techniques will hasten this spreading.

You eventually are ready to acquire those plants you so patiently researched, priced, and ear-marked for your school site. If this finds you near the end of the school year, it would be better in California, especially in the Central Valley, not to put them into the ground until next October. However, you should make provisions for them to be stored and summer-watered. This will assure their surviving the summer. The author ordered about 90 in gallon cans in the spring of 1962, had the nursery set them aside and care for them, then picked them up in a pick-up truck the next October for planting. Others that had been acquired from cuttings and donations were stored and cared for by the principal and this author during the summer. These are but suggestions. You may have better procedures for you.

The best time to plant is in October and November. Early spring, after the last frost and strong winds, and still with some rains to come, is also a good planting time. Nature can help a lot at these times, and you and the pupils will be around to keep things going. The first year is important. More about this later. So, if possible, gather your plants when best suited to plant them.

It should be emphasized that in the long run it is best to obtain good healthy stock from reputable nurserymen. Usually a 10% to 20% discount will be granted if it is made known that they are for such a school project. Whenever possible, obtain stock in three or five gallon cans or balled and burlapped. The headstart you will gain in good root growth will greatly hasten both below

No labor problems: planting to a plan during the noon hour.

and above ground growth. This will result in a more readily apparent reality than would the little twigs from most one-gallon size cans.

This is especially true of trees such as pines, firs, redwoods, and laurels. The bigger the better. Six to eight-feet tall specimens can be had in 5-gallon size for about $5 each. This is *far* better than nursing along five 1-gallon twigs for several years. You are buying years of growth with the larger sizes.

It is perfectly reasonable to expect that acquisition of plants and the planting of them need not be done in one grand back-breaking effort. Take things in stages, first things first. Develop and intensify an area at a time, preferably the woods. Then the large shrubs, because the meadow and bog plants will rapidly catch up in growth and soon give the impression of having all grown up together!

By having several successive plantings, you will spread out the acquisitioning of funds, plant purchases, and the planting itself. Of course, the more you can get done and the sooner—so much the better; but it doesn't have to be all or nothing. By spreading the total development over a period of time, there is always something coming up to be doing. Boys and girls like to have short-range goals—they seem more attainable that way—always something to look forward to. Each year, a little something can be added—wild flower seeds scattered in the grasses, widening or deepening the stream, bird-watching and feeding stations; maybe a weather instrument site, a plant propagation area, more benches in areas where children seem to prefer to spend more time, and a new or modified trail.

Gradually more educational uses and pure enjoyment of the visitations will replace the time spent on site development. These experiences will make it all worthwhile.

Before *any* groundwork is done, be sure to take a *pictorial history* of the site. Colored slides are preferable, but flat prints also will have their uses later. This pictorial history will be invaluable later when you want to develop an appreciation of what went on before. You will probably have occasion someday to encourage others to develop their school grounds for outdoor learnings. The slides will enhance your presentation.

As plants develop and grow, many of the local teachers will want to acquire their own slide collections of the buds, leaves, bark, flowers, cones, silhouettes, general views, and group activities. These will have multiple uses in the indoor classroom studies. Start the slide collection while you are just looking at the untouched site!

It is time to mention *some techniques of planting and groundwork* that will more than reward you in luxuriant and rapid growth.

Consider the present location of any *water pipes and faucets.* These can be used for watering during that all-important first year of maintenance. Consider whether or not to tap onto existing water works for extensions leading to those hard-to-get-at water locations. This should be planned on paper first, then lay out the pipe and bury it only deep enough to be below frost level. One inch pipe is adequate. Generally, it is better not to drag around more than 50′ of hose at any one hook-up.

The stream will most likely emanate from the open end of a buried pipe. Excavate the soil around this open end to simulate a spring as the source of your stream. If desirable, place rocks in the excavated basin. The sound of dripping water enhances the total effect.

Start the stream from the highest part of the meadow or, better yet, from somewhere in the forest where the water will course down-slope into the meadow and thence into the bog. Insert a faucet control somewhere in the pipeline uphill from the "spring". Remove the faucet handle and use it only to regulate the flow as needed. Just before the rainy season you'll want to decrease the flow; during summer increase the flow. A little trial and error will stabilize the flow and thus the level in the stream and in the bog. This is desirable for the water plant and fish life, etc. You will probably only need to adjust the water flow but 2–3 times per year after the initial saturations of the subsoils.

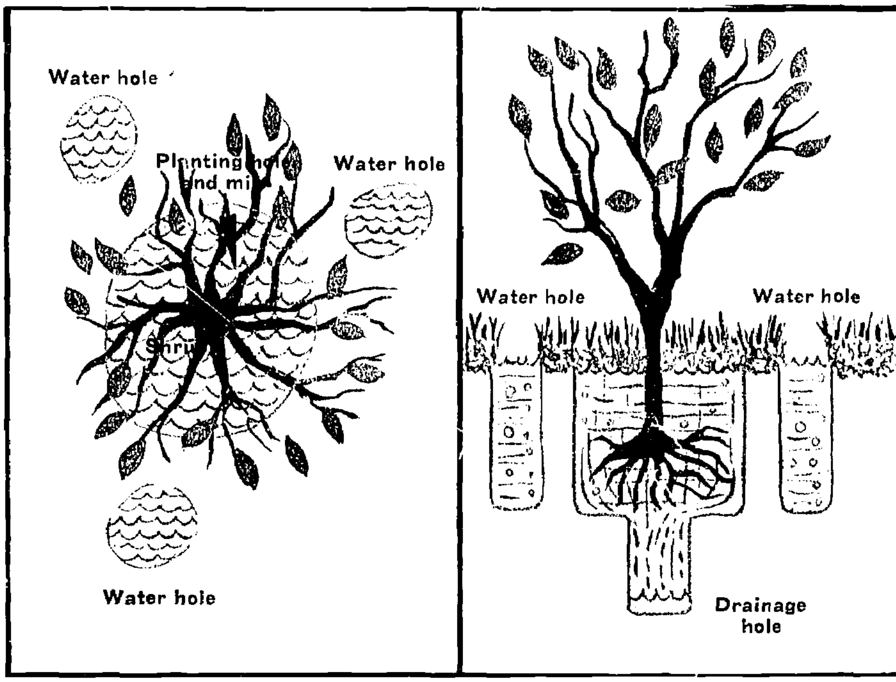
On the original Plot Plan, draw in the *ultimate* sizes of each plant, locating each where it will have room to spread horizontally as well as upright . . . as would be the case in nature, usually. Thus there will be no need for thinning out later on, and each shrub or tree can round out to its maximum potential.

As you sketch in the plants on the Plot Plan, also draw in where you would like to see the *trails.* Use dotted or dash lines to wind along through the forest and meadow, etc. A winding trail affords the hiker differing views every few feet. Such trails also give the impression of greater size to the area and more privacy is sensed. Bend the trail occasionally so as to go *under* the branches of larger trees and thus the walker will not always be out in the open.

In spotting the location of the shrubs and trees, try to group in natural settings, repeating a specimen here and there, clustering certain ones now and then. Realize that there will be changes every few years as the faster growing trees will shade the adjacent plantings. This may or may not be desirable, depending on the needs of the plant concerned. Some plants may be shaded out of existence in time, but this is a lesson in plant succession in itself and should be experienced, not necessarily avoided. However, be sure not to locate a plant that tolerates or needs summer watering next to one that should not have any water other than what falls naturally from the sky! As you researched your plant lists you noted growing and maintenance requirements and this data was to help you plan wisely where to locate them in your school nature center. The Appendix contains some useful data on certain California natives, plus reference material along these lines.

All *planting holes* should be two or three times larger in diameter than was the plant's container. The hole should be at least one and one-half feet deep (more for large trees) with a one foot or deeper drain hole in the bottom. This drain hole can be dug out with a fence post-hole digger. In this bottom hole drop broken pottery, tile, and/or egg-sized rocks. This constitutes your drainage insurance and will need no renewal. Do this even when planting on raised mounds of soil.

Cat-tails and tules take over—and need thinning along trail occasionally.



Do *not* use any fertilizer, now or ever, with native plants. Do use a good soil mix. Mix sand with clay type soils; course sawdust with soils that are too sandy or porous. Decomposing shavings from the primary playpen areas is fine.

Getting the plant out of its container, properly seated in the hole, watering as soil mix is tamped around the plant, etc. are standard gardening practices. However, here is a hint that will pay huge dividends.

After the shrub or tree is planted, take that post-hole digger and dig three holes, each about 1½ feet deep and about 2 feet from the plant, encircling the plant about equally from each other. (See diagram) Keep these holes full of water for a few days. Just hold the hose over the hole and fill up. At first the same holes may seem bottomless as the soil soaks up the water. As the soil absorbs and retains more water, only an occasional refill will be necessary. How often depends on the degree of porosity of the soil at that particular spot (and this is a lesson in itself!). This method of watering is far more effective than sprinkling or irrigation from above. Mulching the soil surface conserves moisture and smothers weed seeds that compete for water and soil nutrients at this critical time in the life of the plant in its new home.

From now on it's mostly a case of:

1. occasional watering (NEVER sprinkle, except grasses in meadow)
2. occasional addition of a shrub or tree.

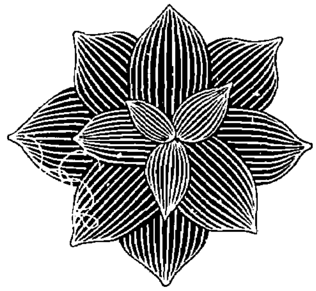
3. frequent surprises . . . where nature took over in her own way.
   Continual observations of similarities, differences, and CHANGES in the environment.
   Structural patterns of leaves, buds, branches, etc.
4. many 'teachable moments' and by-products that were not planned.
5. research projects (by pupils and teacher, individually and in groups) as to habitats and adaptations, early uses by Indians and by early Spanish and Anglo-Americans, and many more that teacher and pupils will uncover in their explorations into the natural world.

The sections coming next on educational uses of this enriched environment on the school grounds will give you many ideas for the children to try out on their own. . . . to observe and investigate this and that, here and there.

You're on your way now . . . all down hill . . . and never again to run out of gas, out of ideas of what to do today! You and your class will know that you have arrived at a new plateau with more and better yet to come.

Enthusiasm is contagious . . . and travels a two-way street.

The primary reasons for all this Planning and Developing were not to do the school district's landscaping for them. (They would not have done it this way, anyway.) What we have been attempting is to create a better opportunity for boys and girls of all ages (and as many teachers as can be flushed out of the Teachers' Room) to get out of the confines of 2 by 4 teaching . . . 'covering' a book while seated within the four walls of a classroom. We want them to really investigate and discover, to *un*cover rather than cover some very interesting and important things.



EDUCATIONAL UTILIZATIONS OF THE OUT-DOOR LABORATORY . . . OPPORTUNITIES UNLIMITED!

Our next considerations are geared for the teacher with no special background in these areas; maybe not even any prior interest in the natural world. Whether the teacher is new to teaching or has been teaching for years, if he or she has curiosity for learning and a willingness to make the effort to 'find out', then for any age level and ability level, teaching via involvement will take on new vigor and hope. Experiences for the less able, for the more able, and for the forgotten in-betweens will enable all to have a spot in the sun and to be challenged in new ways.

As soon as Planning and Developing have started, you, the teacher, have the setting, the locale . . . just on the other side of the classroom door!

SOME PREFATORY STATEMENTS FOR EDUCATORS . . . Each and every idea herewith presented, every activity written up for your consideration and application, every outcome mentioned, has been a personal and direct experience of the author. Nothing has been intended as a rehash of someone else's library research. Most, but not all, of the activities originated within the outdoor laboratory in the Bowling Green Arboretum and Nature Center in Sacramento. The results are field tested. Many started with a pupil's "What if . . . ?" Many resulted from the author overhearing interesting comments from pupil to pupil. The growth in breadth and depth of ideas, concepts, and suggested investigations from such sources is fantastic. No preconceived lesson plan could accurately detail what would be learned in any time block. It would be criminal to limit the mind to such narrow preconceptions as only one person, a teacher, could devise.

THE TEACHER LEARNS RIGHT ALONG WITH THE PUPILS, IN MANY INSTANCES . . . Why not? If we wait to become an authority on plants, on insects, birds, soils, micro-climates, plant successions, ecology, etc., and *then* venture into leading the class through such lessons . . . we'd all never get started. Don't hestitate to admit you don't know everything. The knowledge explosion of the past two decades precludes that you ever will know all the facts, or even enough to adequately 'cover' the topic in a school year. There just are too many facts. Concepts, on the other hand, last a much longer time and can be learned as a culmination or on-going process of activity-learning. *The process is the thing!*

There are *many subject areas and sub-areas* that can be explored in *an indoor-outdoor learning laboratory.*

The listings soon to follow here are but partial in scope. You will add to these suggestions as you progress.

Inter-relatedness should be brought out whenever the opportunity presents itself. As you scan this listing, do not concern yourself with how many lessons, days, weeks, etc. would be spent on each. Obviously, there's too much here for in-depth study in one year; and a hasty skim-over to 'cover' the total offerings would be of little value.

Instead, consider the season at hand, so as to be timely. Consider special interests and abilities of pupils, what *seems* to be important in the local environment. Keep tuned in. Likely, you will feel more secure at first in those subject sub-areas with which you are more knowledgeable. You'll be more comfortable leading with your strong suits. Later, as confidence builds up, you'll want to broaden your own learnings . . . and you will do so using the children and the outdoor laboratory as it should be used—to try out new "what ifs . . .", new methods that will come to you like flashes of inspirations, new successes, and the chance to cope with newly acquired *non*-successes!

SOME SUGGESTED INDOOR-OUTDOOR LEARNING AREAS AND SUB-AREAS

Bird Study—Identification, environmental habits, in-migration and out-migration. Effects of seasonal changes. Photography of.

Weather Study—Observations, data gathering, forecasting, record-keeping, micro-climates within the nature area.

Insect Study—Observations, environmental factors, role of micro-climates, collections, identification, experimental physiology and biology (metabolism, locomotion, respiration, circulation, digestion, colorations, and adaptations).

Soil Study—Observe, experiment, test, analyze . . . porosity, leaching, percolation, humus content, composition, nutrients, relationship to local vegetation.

Plant Study—Clues to systematic identification, creation of useful 'keys', native habitats and adaptations to present environment, seed dispersals, plant successions, propagation techniques, competition for survival, role of micro-climates, pollen collections and counts, microscopic study of cell structure, early uses of plant parts by Indians and early settlers. Controlled and uncontrolled studies.

Water and Water Life—Bog water and stream water through the microscope; presence, growth, and diurnal movements of algae; adaptations and habits of introduced life (fish, toads, frogs, snakes, birds, etc.)

Mathematics—Indirect measurements of tree heights, of distance to objects; taking and plotting of magnetic compass bearings, computations of irregular areas and shapes, contour mapping, determination of slope and differences in elevation, role of sets and subsets, Venn diagrams, determine Fibonacci numbers, sampling techniques, scale drawings; measuring, counting, predicting, graphing, tabulating.

Photography—Skills of close-up photography, landscapes, and identification views; collections of colored slides for photo essays, for classroom learnings of plant changes from genesis to exodus; for ecological translations (What's The Story?)

Language Arts—Oral expressions of curiosities, of observations, of inferences; vocabulary and proficiency in exactness of expression, growth in formulating ideas and concepts (orally and in writing), in-depth research reports, dramatic presentations in the natural setting (Music Circus in the round), compose and distribute a monthly nature newsletter.

Art—Poster designing, leaf prints sketches, form and proportion, flower arrangements, attention to details of composition, impressionistic portrayals of a visit to the nature area.

Other—Set up physical science site for use of pulleys, inclined planes, levers of suitable size and strength to support one or more children—permanent or portable equipment; attainment of scout *proficiency tests* and *badges*.

development of a *What and Why Display*.

development of a *smell box*, of a *feel box*.

training of *pupil-guides* for groups of visitors.

aesthetic presentations of nature slides with recorded music.

development of an *intensive research project*.

Playing detective is one way of gathering "clues" for plant identification.

Water seeks its own level—as do pupils' interests and curiosities.

correlate local learnings with larger communities (life zones, other states or countries).

use of a meeting site for scout and other groups.

TRANSITIONS FROM INDOOR TO OUTDOOR CLASSROOM . . . Guidelines for good teaching are pretty well known and not intended to be repeated here. There are, however, certain mechanics of smooth transitions to outdoor 'lessons' that are particularly valuable.

Rules for behavior are very important indoors and outdoors. In the outdoors there is much less eye-contact and less opportunity to get the attention of an inattentive person.

THE MAIN RULES OUTDOORS ARE . . . Know the purpose for being in the outdoor laboratory on that day . . . to observe this or that, to measure, to gather data, etc.

Stay on the trails.

Don't run or otherwise engage in horseplay.

Observe and enjoy—don't destroy!

Be prompt in returning to indoor class on cue.

Basically, the rules are few and simple; hold the pupils to them at all times. Be consistent, firm, and fair. Plan the initial phases of the outdoor experience so that there is no time for dallying. Aesthetic appreciations come from a *quality* exposure to the outdoors, not from misuse and abuse of the outdoor environment!

The first approach to using the outdoor environment for learnings should be casual and once-over-lightly. No pushing for feedbacks, no unnecessarily structured do's and don'ts—just a short walk along some trails. Occasionally, stop, look around, then continue onward. Upon return to the indoor classroom, encourage some feedback by being a good listener. Do not be disappointed that not everyone saw, felt, heard the same things or to the same degree. Impressions depend on receptors and expressive skills. These come with time and practice . . . later.

The next exposure should include preliminaries like behavior standards (until reminders are no longer needed) and that this time they should be looking for evidences of CHANGE since the last tour. It is amazing how much children notice and don't notice! Some will aver that certain trees were not 'there' the other day. The ensuing indoor discussions could follow through with what was noticed today that wasn't there or had changed since last time.

By now you, the teacher, should have jotted down several little gem ideas that could be followed up on visitations in the near future.

Soon you will sense *the need to be more directive*. Start fulfilling this need, but don't overdo it . . . just enough to give almost unobtrusive *guide lines* . . . not a list of questions to answer or things to be done . . . don't stifle enthusiasm and curiosity . . . just *guide* it.

"Why caterpillars on this bush but not on others?"

The Discover and Investigate activities coming up on the next few pages are intended to do just these things . . . guide without being too directive.

"What's The Story?" is a question to be used over and over again as new encounters and situations come into play.

Hypothesize, then plan how "we can find out".

It won't be long before challenges will be attacked in more streamlined, more productive manners. A process is being evolved via personal involvement and developing problem-solving attitudes.

To follow through with these thoughts, it is suggested that a file card be plainly printed up (use a felt pen) for EACH of the "Discover and Investigate" activities on the following pages. Each represents a pupil-guided experience . . . at his own pace . . . in his own way.

The entire class can follow the Discover and Investigate card for the day, jotting down the 'instructions' before leaving the indoor classroom with notebooks or clipboard.

Another method is to select two or three appropriate-for-that-day D & I cards, post them in a conspicuous place daily, letting pupils select one for first observations; then the others in turn at the time the pupil is ready for a change. This way, one's observations and inferences gained from one D & I card often relate to the data observed on another card. Correlations and interrelatedness begin to tie in.

An everchanging, ever-revealing library of living things.

D & I cards can be rotated, not by the calendar, but as learning and environmental requirements change. This is where the teacher-judgment comes into play—based on close attunement to just what seems to be being experienced. Obviously, this cannot be pre-planned.

Encourage the class to ferret out as much information as they can find. Have available a varied and rich science library—in the classroom. Ascertain what is available in the school library, the city and county library, etc. Encourage them to talk these things over at home, in the neighborhood. Let them gain more insights and viewpoints than you alone can give them. Share these other resource findings with the class. Be generous with praise and recognition for extra effort. Don't be hasty in your judgments . . . at least in your pronouncements of them . . . you might be embarrassed when more evidence comes in!

The Appendix lists some very useful publications for elementary and junior high students, in addition to those readily available in most classrooms or school libraries. Enrich your offerings, make reading for a purpose more rewarding than ever before!

Introducing Pupils to Observations . . . Give these D & I Cards and techniques a good try. Time things right. Be patient. Wait for the spontaneous and meaningful feedback that is sure to come. Keep a notepad handy at all times. It won't be long before you'll be glad you brought your camera to school today, and every day! The by-products of each excursion will contain some gems for the future. Add some of your own D & I cards to the file.

STRATEGY AND TACTICS FOR TEACHING SCIENCE (Elements of a Teaching Strategy)

Opening Stage . . . Provide activities designed to determine the degree to which the students already exhibit, in terms of observable behavior, the specified objectives for the learning sequence.

Include activities which help the students make a connection with their own experience and tie the new learning sequence to those that have preceded it.

Introduce experiences that arouse interest and motivate student involvement in the new learning sequence.

Developmental Stage . . . Provide a variety of opportunities for students to develop needed skills and knowledge in sensory perception and critical observation.

Select materials and situations which give students opportunities to obtain data relative to the particular product and process of science that is being studied.

Devise learning experiences which develop student competencies in recording, organizing, quantifying, and communicating in conventional scientific form.

Emphasize experiences which lead to the student's conceptual comprehension of the data.

Confront the students with interesting objects or events which do not conform with their prior comprehension.

Guide the students to design and carry out critical investigations to explain the discrepant or related objects or events.

Contribution Stage . . . Guide students to evaluate perceptions, data, concepts, hypotheses, processes, and theories which are used or developed during critical investigations and during other learning experiences.

Devise activities designed to summarize and apply what has been learned and to set it into a larger framework.

THE TEACHER'S ROLE IN THE TEACHING-LEARNING PROCESS. . . In order to promote intelligent behavior, the successful teacher must focus his efforts upon planning for use of the higher-level mental processes . . . by providing opportunities . . .

to use multiple ideas and see multiple relationships.

to generate novel ideas.

to test the relevancy of ideas.

to work with alternatives and their responsibilities.

to form generalizations and concepts.

to make discriminations

to foretell consequences.

to work for the expansion as well as the refinement of an idea or concept and to intensify their purposes for learning.

A CLASSROOM ATMOSPHERE THAT INVITES LEARNING

1. An atmosphere where children work frequently at their own problems.
2. The presence of a teacher not easily disturbed by spontaneous requests.
3. The adjustment of teacher program planning to take advantage of the immediacy of the problems of learning.
4. The awareness of personal-social influences in the children's lives and the relating of these influences to the problem at hand.
5. The perception of difficulties and knowledge of the causes of difficulties in problem solving by use of diagnostic and analytical means.
6. A teacher who makes of his classroom an inviting atmosphere for learning.
7. A teacher who can listen for the cues of learning in the ideas expressed by children.
8. A teacher who can influence children to practice needed skills.
9. A teacher who realizes that the value of an experiment lies more in the means it presents for *exploring the unknown* rather than in verification of the known.

INTRODUCING STUDENTS TO OBSERVATIONS —Discover and Investigate

Here are the texts of a number of Discover and Investigate cards the author used at Bowling Green Arboretum. You will find most of them useful on the nature area you plan to develop.

1. Walk to the middle of the forest.
2. Look around.
3. What will happen to the insects here when the trees are twice as tall as now?
4. What will happen to *some* trees when south winds blow? North winds? Why?

1. Walk along a trail.
2. Find a shrub about as tall as nearby grasses.
3. Will the grasses keep growing as tall as the shrub? How do you know?
4. Can you predict what this spot will look like 1 yr. from now? 5 yrs.?

1. Walk along a trail. STOP. Look around. Walk some more.
2. Do you see any evidence to make you think more rainfall will soak into *some* soil than into other soils nearby? Why or why not? How could you find out????

1. Follow a trail for about a minute.
2. Stop at the nearest tree or bush.
3. Look at the leaves very carefully.
4. Does the flat side or the edge of the leaves face the sun?
5. What does this tell you about sensitivity? about conserving moisture?

1. Smell the needles or leaves of several trees or bushes.
2. When you get a definite odor, try to describe it and compare odors with other leaves and also with other odors you have smelled in the past. Use as many descriptive words as seem to apply to the odors.

1. Find a needle-bearing tree.
2. Count the needles in a single bunch. Count them in another bunch on the same branch.
3. Are there the same number of needles in each bunch? Should you sample a few more bunches or do you have enough evidence to identify this tree according to the number of needles in its bunches????
4. Do the same kind of counting on another needle-bearing tree. Compare results with your observations of the first tree. What are your conclusions?

You may have noticed that most leaves are longer than wide. We have *some*, however, that are as wide or wider than they are long. Can you find them? Do you think they are on the same kind of tree? Can you *name* the tree? How could you find out the kind of tree you observe?

1. Walk along a trail. Stop and look at a shadow on the ground.
2. About what time of day is it?
3. Can you now tell pretty well the general direction of North?
4. Try this method several times in the day and on different days. Does your method work?

Walk along a trail. Stop and look at the shadows of two nearby trees, one quite taller than the other. Is there any relationship between the heights of the trees and the lengths of their shadows? Explain.

Take a short trail hike. Stop. Sit on a bench. Look around. What seems to be *different* since your last visit by or near here? What seems to be just the same? Has anything been added or removed? Has mother nature been working or sleeping on the job?

Go sit on a bench. Look up at the sky . . . in all directions, slowly. Keep looking. Is anything changing before your eyes? in what way? Can you predict what a certain portion of the sky will look like in 10 min.? Take another short walk. Come back to where you were 10 minutes ago. Look back up into the sky. Did it change like you predicted it would???

Look at the leaves or groups of needles on a branch. How are they spaced and lined up along the branch? Is this growth pattern the same all along other branches on the same tree?

Repeat the last procedures but on branches of a different tree. Compare your findings with those of the first tree you observed a few moments ago. Could this comparison help you identify trees? How?

Walk along a trail in the meadow. Stop beside some tall grasses. Place the back of one hand on the ground on the trail. Place the back of your other hand on the ground in the tall grass nearby. What do you notice? How does this 'fact' affect local wildlife? Explain.

Tour the boardwalk into the bog. Then walk along the meadow's edge. Stay on the trail. Keep walking along the border of the meadow and the forest. Is there any evidence that . . .

The meadow is moving into the bog?
The bog is moving into the meadow?
The stream is moving into the bog?
The meadow is moving into the forest?
Can you explain your observations?
Can you predict what changes will look like in a few years????

Walk along a trail. Look at several bushes and trees. Look at them from the side and other views, not just from in front. Do you see any evidence that the *sun* has affected the growth pattern of that tree or bush? How has the wind, over periods of time, affected *some* trees in the Arboretum?

As you walk along most any trail, keep your eyes open, looking *under* as well *as on* leaves and branches. Also look on the litter beneath the large plants. Do you see any creatures that eat plants? Do you see any creatures that eat other creatures? Read about the *food chain!*

Some trees are HOGS! They hog the sunshine. They hog the food. They hog the water. They starve their neighbors.

1. Find some examples of tree hogs.
2. Explain why each is a hog.
3. Predict what the results (growing-wise) will be at each instance by next year.

1. Sit on a bench for a few minutes.
2. Look down and around.
3. What living things *could* or are living nearby?
4. Would enemies of these living things also live or visit here from time to time? Explain. Is there a food chain operating here?

1. Take 20 steps in any direction from any entrance to the Arboretum.
2. Stop. Look around. Keep looking.
3. If a hungry bird came where you now are, would it likely get a larger meal from insects or from seeds? Why?
4. In the early morning visit the arboretum and sit quietly. Watch for birds near this spot. What kind(s) do you see? Draw a sketch of bills seen.

In the bog notice how certain plants are grouped. Do you see smaller groups of the same kind growing some distance from the parent or larger groups? How do you think they got where they are? What does this tell you about prevailing winds at seed-ripening time?

We do not usually put out food for birds or other animals. What 'natural' foods, and 'who' might eat them, do you find in the Arboretum? Are some of these natural foods to be found in *all* or only *some* parts of the Arboretum? How would predators take advantage of this information?

1. Take the trail walk to the edge of the stream.
2. Creep up to the edge quietly.
3. Watch the movements of the fish for several minutes.
4. Do they seem to have a preference for certain depths?
5. With a thermometer (or your hand, gently), determine the temperature of the water at the surface, at the bottom, at the depth the fish seem to prefer (if not at the top or bottom).
6. Does water temperature seem to have any effect on their activities?

1. Take the trail walk to the edge of the stream.
2. Quietly watch the movements of the fish for a while.
3. Select a certain fish to concentrate on. Watch it carefully.
4. Does this fish roam aimlessly? Does it have a pattern of movements?
5. Does this particular fish pay particular attention to other fish, same size, smaller, or larger than it?

Plants Have Feelings, Too! Feel, but do not pick, as many different leaves or needles as you want. Do the upper sides of the leaves or needles feel the same as the under sides? Could the feeling of a surface have anything to do with the leaf holding on to its moisture inside? Could the 'feel' of the leaf have anything to do with protection from leaf-eating insects? Explain.

Could the *kind* of leaf *surface* affect the holding of rainfall long enough to be absorbed by the leaf? Could the surface of a leaf affect the erosion of the soil beneath the plant? Explain.

Take a short walk. Look around slowly and carefully as you walk. Do you see any evidence that small creatures are making it easy for water and sun heat to enter the soil? Explain.

STUDY AND RESEARCH TOPICS . . . On the next three pages are some study-research topics for classroom use. They are divided into Primary, Intermediate, and Upper. However, grade levels should not be rigid boundaries but rather as guidelines for ability-interest levels.

These study-research topics are beginning to require more abstract reasoning, more deductive and inductive thinking. In order to 'understand' the total environmental factors involved, the pupil should be guided through selective readings that show the interdependencies of all living things. Terms like expendable and non-expendable resources, renewable and non-renewable resources lead into social-economic implications—some quite controversial and should be presented as such—for the student to become better acquainted with the 'world outside'.

Don't hesitate to modify the topics, to enrich them, or to encourage your associates to try them out with their classes. The Social Studies or geography courses could integrate these topics quite easily, thus enhancing offerings in those fields, too.

PRIMARY GRADES

Some Suggested Investigative Research Experiences Leading to an Ecological Approach to Conservation.

1. What are the roles and responsibilities of family members with regard to conservation? father?, mother?, children?, in the home?, on the highways, on camping trips?, in parks and gardens? In what activities may children engage at school to develop desirable concepts and practice their role?
2. What responsibility can children assume for the care of buildings, grounds, and equipment that will develop concepts of conservation, make a real work contribution and not increase the work of the custodian?
3. Does equipment for work-study OUTDOORS include a garden plot and tools? a wild area? cages for small animals in appropriate location for their care?
4. What necessary foods do we eat daily or frequently? What conservation concerns are related to food? Which of these concerns can be part of the school activity of children?
5. What are the interrelationships between living and non-living things that create needs for conservation practices? How are wood, rock, sand, and glass developed by nature? utilized by man?
6. In what ways may homes differ with respect to conservation interests and practices? Could conservation be suggested to a parent during a parent-teacher conference as a topic for family table talk? Could a teacher suggest development of family interest in conservation as a way of helping children in school?
7. What new ideas and inventions related to conservation have brought about changes in homes? What conservation implications are there with regard to television, frozen foods, cake mixes, TV dinners, automatic washing machines, detergents, and swimming pools?
8. In what conservation projects might a school engage to serve the community effectively??

INTERMEDIATE GRADES (4–6)

Some Suggested Investigative Research Experiences Leading to an Ecological Approach to Conservation.

1. What features of Calif. topography and climate contribute to the need for extensive conservation practices? What questions might come up while examining a topographical map? what questions relating to water supply? to water sheds? to soil? to temperature variations? Mountain barriers?
2. In the growth of agriculture and industry in Calif. what natural factors have been most seriously disturbed?

3. What differences between past and present farming and manufacturing have created conservation needs? What practices have helped to alleviate the drain upon natural resources?
4. If technology uses natural resources at a rapid rate, why do scientists, engineers, and inventors continue to study still further technological development????
5. What conservation concerns and practices have gained national and international recognition for California??
6. What conservation imprints did various groups of people leave in the development of Calif.? Were forests more widespread in earlier days? Did early settlers make extinct or nearly extinct any wildlife species??
7. What communities in Calif. were develop d on their present sites largely due to abundance of what natural resources? What natural resource(s) played an important part in the development of the area where your school is?
8. What aspects of life in the missions were related to conservation needs and practices? Did the making of adobe bricks create a conservation need? What natural resources were utilized in quantity at the missions?
9. What controversial conservation problems might be discussed pro and con by pupils? What skills and knowledge of conservation would be helpful to a panel leader of such a discussion?

UPPER GRADES

Some Suggested Investigative Research Experiences Leading to an Ecological Approach to Conservation.

1. Are any of the reasons for present day migration to the U.S. related to the abundance or scarcity of natural resources? to needs for conservation practices?
2. What conservation factors helped bring on the Civil War? What natural resources were important in carrying on and ending the war?
3. What concern do unions have in conservation of natural resources? Do any trade unions have written statements with regard to conservation needs and practices? What resources and activities may help pupils locate answers to such questions?
4. How may government change the use of natural resources and conservation practices as needed?
5. What issues are involved in proposed modification of use of natural resources and conservation practices?
6. In what ways is the use of natural resources and conservation needs and practices related to the rights of all people in our American way of life?
7. What natural resources continue to be available because of conservation practices? what have been depleted?
8. What is meant by 'planned obsolescence' and what are its implications in our social order? in our way of life?

9. How does 'planned obsolescence' conflict with the concept of 'stewardship' of the natural world???
10. Did immigrants tend to settle in regions with natural resources similar or quite different from those of their homeland? What characteristic of early settlement made settlers from Europe aware or unaware of conservation needs?
11. What natural resources influenced the grouping of people of the areas into nations? In what ways is conservation related to economic "values" of a nation? by concern for the next generation? by dire necessity? by the struggle for survival?

ACTIVITIES VIA PERSONAL INVOLVEMENT

Alterations to the Environment of Fish in Stream . . . Part A.— Especially adaptable to stream life.

I. *Effects of aeration on the fish.*

A. With a tire pump or P.E. Ball pump, pump air into the stream near the stream bank.
Are the fish attracted or repulsed by the stream of bubbles? In what way? Do you have any idea why??

B. Attach a longer hose to the pump. Pump air onto the bottom of the stream farther out than before. Do the fish react at all? Describe your observations.

C. Vary the speed of pumping near the bank, then near the middle. Does this make any difference to the fish?

D. If the fish could not see you as you pump, do you think this would make them act any differently? How? How could you pump air into the water without being seen? Try out your idea and make observations as before. Compare your results now with A,B,C above.

E. Try any of the methods A,B,C,D above, then after pumping a few strokes, sprinkle lightly a pinch of fish food onto the water just above the air bubbles. This could be a 'reward' to them for cooperating by responding to the aeration. Keep a record of how well they do respond to this method of aerating and rewarding, the 1st time, 2nd, 3rd, etc. What are your conclusions???

In any of the investigations above, were there some fish that responded quite differently from the majority? How could you account for this?

In what other ways do you think fish could be 'trained?'

To investigate whether fish have good memories, try out some of the above methods several days or a week later. Record your observations. Compare with the similar experiment tried several days or a week ago. Do the fish respond in the same manner as before . . . if so, do they do so quicker, as quickly, or slower than before?

Alterations to the Environment of Fish in Stream . . . Part B.— Especially adaptable to stream life.

I. *Effects of a blinking light on fish behavior.*

Hook up a blinking neon lamp to 90 volts battery and deposit this setup into a quart mason jar. Lower into water. Some added weights may be needed. Stand back from edge of stream and observe the reactions of the fish.

Do all fish respond in the same manner? If not, why not. Describe your observations. How long does the effect seem to last. Is curiosity or indifference a good way to describe their behavior?

Do some fish seem to change their behavior?

Do some fish seem confused? Afraid?

Repeat the experiment in a few days. Are there any changes in behavior? What does memory have to do with this experiment? In what ways could you use this device to 'train' the fish. Try out your ideas! Did things happen the way you predicted???

II. *Effects of an electric buzzer on fish behavior.*

Instead of a blinking light, attach a small electric buzzer to a flashlight battery, bolt the buzzer to the inside of the screw cover of the jar. Seal cover with melted wax. Lower the jar with buzzer into several spots in the water, one spot at a time. Make observations as you did with the blinking light. Compare results with those of blinking light.

Do you suppose the fish are being bored, scared, or confused by all these strange changes in their environment? Would these possibilities affect their behavior? How could the experiment be done under 'fresh' or 'new' conditions?

III. *Effects of both buzzer and blinker on fish behavior.*

Lower both the buzzer and blinker into the water, side by side. Observe carefully. What do you think will happen if you move buzzer several feet from blinker. Try it and find out.

Determining Mineral, Humus, and Moisture Content of Soil

Equipment . . . Flask or coffee can with lid.
Heat source
Soil samples, approx. 1 cupful of each type available.

Procedure . . .

I. Dampen a portion of each of the soil samples. Do this separate from the main portion of each sample. With red litmus paper, test the acidity-alkalinity of each sample. With blue litmus, also test each of the same sample portions. Label each sub-sample with your findings. Set these samplings aside. Note the origin of each sample just tested. What plant life is growing in each sample-source?

Take a few leaf and stem samples from the region whence the soil samples came. Crush and moisten each plant samplings. Test each with red and blue litmus.

Are these acid-alkaline reactions the same or different from those testings made of the parent soils previously??? Is this what you expected?

II. Weigh carefully an "empty" flask. Place several ounces of one of your samples in the flask. Weigh carefully the flask and soil. Record. Apply external heat for several minutes. What happens? Why? Was there humus in the soil? How do you know? Where is it now? When no further change is noted in the soil, remove from heat. Weigh flask and contents. Record. Compart with your first weighing.

What is the ratio of humus to minerals? Was there any moisture in the original soil sample? How do you know? REPEAT the above procedures with each of your remaining soil samples.

III. *Extended Research*

A. Select several soil samples from different spots around one tree. Be careful not to damage surface roots. Number each bottled sample. Sketch a plot map showing the tree and relative location of each soil sample. Note distance from tree, shady or sunny side of the tree, slope of surface being studied, etc. Investigate, using litmus paper and heat treatment described in I and II, previous page.

What is the uniformity of soil contents in your test area? Go back to the tree, walk around it slowly, looking carefully for evidence of different growth rates and patterns from several views. Does the soil seem to have any bearing on growth differences?

B. Examine soil particles under a low power microscope or hand lens. With tooth picks, try to sort out the various types of particles. Note the ratio of the different particle-types . . . by volume. Is there any 'life' in the sampling? Discuss.

C. Mark off a square one foot long and one foot wide. Dig down one foot. Carefully place all soil excavated onto a large white sheet or tough paper. Weigh this cubic foot of earth. Sort out all different particles. Place into small glass containers all insects, worms, larvae, etc. List and/or sketch each different item sorted. Weigh each sorted pile and compare with the total weight. Can you predict what ratio of each different portion just sorted will be found in a plot 100′ by 100′ in the vicinity of your sample?

D. Place into several empty quart jars an equal volume of soil samples. Add an equal amount of water. Try about ⅔ soil and ⅓ of jar water. Shake each covered jar to mix soil and water. Allow to settle for an hour or so. View the distribution of the settled sediments in each jar. Sketch a cross-section view of each distribution. Which soil would be best for cacti? azaleas? road foundations?

Water Evaporation Rates in Different Habitat Areas

Use several paper towels . . . same sizes. Indelibly number each one. Thoroughly wet each towel, then press out the water until the towel no longer drips. Attach each towel with a clothespin to a twig or weed in the area to be tested. Also lay some on the ground and in tall grass. Compare and record the order in which the towels dry.

What is it in each area that makes the towels dry slowly or quickly??

Devise a tabulation showing sun, shade, varying heights above ground, wind and exposure, presence of large objects and their relative positions to the indicator-towels, puddles, dust, etc., etc.

Try to conclude from the data gathered some general conclusions that seem to be valid.

Try to relate your findings to some practical applications in a situational problem. Write it out for others to discuss and analyze.

RATE of Water Penetration into Soil

Using several soup or juice cans, remove the tops and bottoms. The bottom lid should be removed so that the edge is sharp.

On the spots to be tested, press the sharp lower edge of each can about ¾ths of an inch into the soil. Fill the can to the brim with water. Using a watch with a second hand, time how long it takes all the water to leave the can and enter the soil below. Record this time and repeat the procedure with cans in different portions of the test area.

These times give a rough comparison of the rate of water penetration. Devise a number scale to represent the slowest and fastest penetration plus intermediate penetrations.

Into what kind of soil did the water run most easily? Is there any relation between the compactness of soil and water penetration? Why should cattle not be allowed to graze on forest lands? Why does the surfacing of roads affect water penetration? water runoff? Why do cities have such problems of rainfall removal after a storm?

Does the presence of worm and insect burrows and plant roots seem to have anything to do with the rate of water penetration? Would you say that gophers are beneficial? Explain.

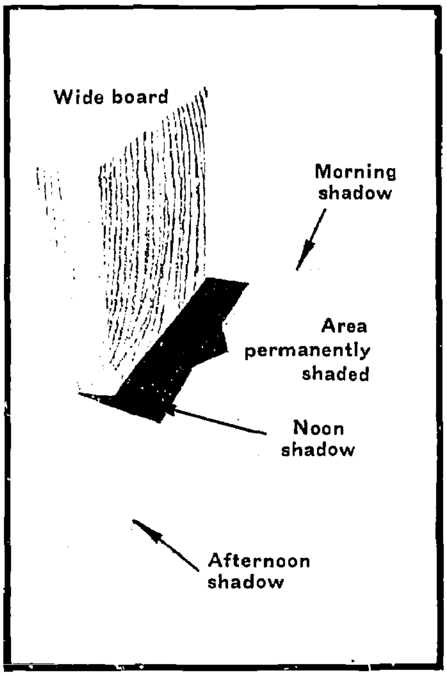
If all the cans are left in position and the test is run over again on the wet soil, how do you think your results will compare with previously? Try it and see!

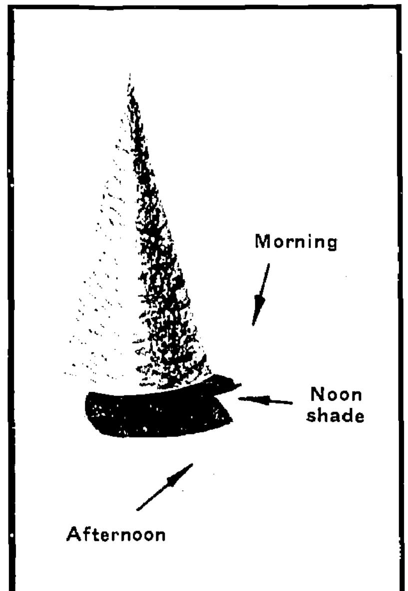
On the basis of these tests, what kind of cover and soil should be on the headwaters of streams and within the drainage areas of reservoirs? Explain.

Applying some of the knowledge you have gained from these tests, how could you make sure that newly planted trees and shrubs would not dry out as the root level?

Light Intensity and Ground Cover

Procedure . . . On a lawn, sidewalk, or field, place stones or small stakes along the edges of ground shadows cast by trees or other objects. By doing this at intervals during a sunny day, areas of permanent shade, partial shade, and permanent light may be located.

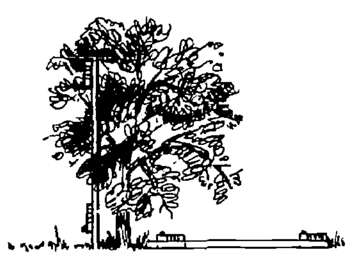




Where is the permanently shaded area?

In the areas of sun and shade, are there differences in soil *temperatures?* Lay a thermometer on the ground, bulb side down, and record temperatures. Do differences in light have anything to do with kinds of plants found there? Do differences in light have anything to do with growth of plants found there? Are grasses dispersed evenly in quantity around the tree? Are grasses taller in some of the test areas? Denser? Same color? What other things do you notice about ground areas with differing light intensity? Which area would be best for planting petunias? day lilies? Begonias? In a pasture with a large tree as above, where would be the best location for a water trough? Why?

In planning to plant a tall tree in a back yard near a lily pond, what would be your considerations?



TEMPERATURE STICK
for Micro-climate Observations

Equipment . . . One or more 1½ in. by 1½ in. by approx. 6′ stakes. Two standard wall-type Fahrenheit thermometers per 'stick.' One wood screw per thermometer. Mount the two thermometers on same face of the stick,—one about 1 in. from lower end, the other 5′ up the stick, measured at the bulb end of each thermometer.

Activity . . . 1. Stand the stake upright on shady side of a large bush. Let branches support stake or tie upper portion to a branch. Take periodic readings of both thermometers. Record.

Is there a difference in upper and lower thermometers' readings? If so, is the difference constant? Graph several successive readings. What are your conclusions as regards: hourly changes in each thermometer? relationship between temps and density of shrubs foliage? effects of insolation? possible presence of micro-climates? role of the soil surface of the immediate area? stratification of air layers near this shrub? bird and insect mobility and habitat within the immediate area? vertical area movements? Advective air currents and their temp.?

2. Place the stake on different days on the sunnier side of the same shrub as in #1 activity. (Rotate stick slightly so as to keep thermometer out of direct sunlight.) Compare results with #1 above. Analyze and conclude as far as evidence seems to warrant. Make inferences as to air layers present and their relationship to presence, growth, and development of birds, insects in and around this shrub.

What effects does the soil surface type seem to have as a climatic control? Consider humus, topsoil, soil particle size, dry, moist, etc. How can you test to see some evidence of heat reflection and absorption by this soil beneath this shrub?

Notice the sizes of the leaves or needles on sunny side and on shady side . . . at lower, middle, and upper parts of shrub. Inferences????

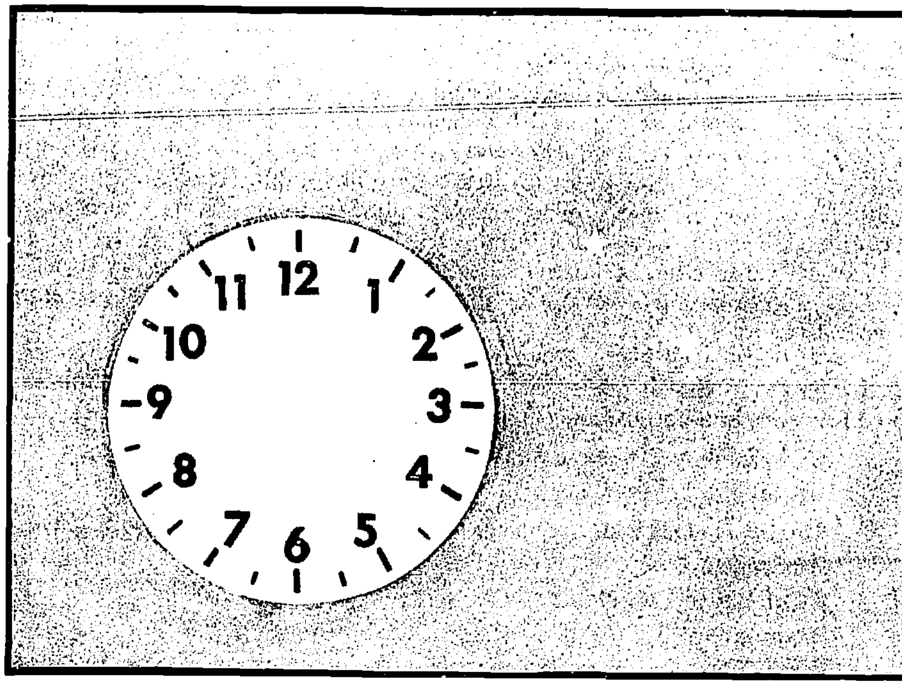
Notice the variations in shades of color of leaves and needles on sunny side, on shady side . . . lower, middle, upper portions. Inferences?

Notice the direction of longitudinal axis of leaves . . . pointing same or ???? in different portions of shrub. Inferences?????

3. Place *several* such thermometer stakes in various parts of the outdoor area . . . sun, shade, exposed, protected, etc. Record observations. Number thermometers for ready reference. Plot a profile of air layers of the observed locale. Plot an air contour chart of the same area. Prepare some statements of inference and related correlations based on your observations plus related study of habitats and biology and microclimates. See #1 and 2 above.

4. Place several thermometer stakes INDOORS. (a man-made microclimate!) Place near doors, windows, in corners, behind large pieces of furniture, in middle of room, elevated sections, etc. Record several observations. Include a sketch or room and location of thermometers. Number each thermometer for reference. What is the role of the room's ceiling? the floor? Compare *this* man-made microclimate environment with a natural environment. Consider the condition of the trapped air and its insulating blankets.

Suggested refinements . . . 1. Attach more than 2 thermometers to each stake. 2. Set stake up on table or shelf (indoors.) or attach a hook, open ended, to upper end for supporting to a higher branch outdoors. 3. Place humidity indicators near each thermometer. Record temps, analyze, conclude. 4. Run a series of test observations during night only. Note presence of cloud cover, surface winds, condensation pockets, etc.



HOW TO TELL TIME BY POLARIS AND URSA MAJOR

Face the North Star (Polaris) and imagine the center of a large clock dial to be 'on' Polaris. Consider the pointers of Ursa Major to be the hour hand of the 'clock.' To tell the time, follow these four simple steps. . . .

1. 'Read' the time on the Sky Dial to the nearest quarter of an hour.
2. To this number add the number of months that have passed since the beginning of the year, including the elapsed portion of the current month to the nearest quarter of a month.
3. Double this sum and subtract from $28\frac{1}{4}$. [If the doubled sum $> 28\frac{1}{4}$, then subtract from $52\frac{1}{4}$].
4. The number obtained represents the number of hours that have passed since that day began at midnight, using "24 hour time or 'military' time."

EXAMPLE . . .

Take the date of April 12, at which the 'pointers' will be at quarter past one.

1. Sky Dial time = ... $1\frac{1}{4}$
2. Number of months since New Year's Day .... $3\frac{1}{4}$

$4\frac{1}{2}$

3. $4\frac{1}{2}$ doubled = 9. $28\frac{1}{4} - 9 = \underline{19\frac{1}{4}}$
4. $19\frac{1}{4}$ hours since last midnight = <u>1915</u> hrs or <u>7:15 p.m.</u>

FIBONACCI NUMBERS IN NATURE

LEAF ARRANGEMENT . . .

The arrangement of leaves in plants is called phyllotaxis. From the standpoint of Fibonacci numbers, two things are observed. (1) The number of leaves it takes to go from any given leaf to another leaf similarly placed on the stem. (2) The number of turns as one follows the leaves in going from one leaf to the next leaf similarly placed. Both of these numbers turn out to be Fibonacci numbers, in many instances.

As a reminder, a Fibonacci sequence would be like 1,1,2,3,5,8,13,21, etc. . . . wherein each term after the first two is the sum of the preceding two terms.

In the case of leaf arrangement, the following type of notation is used. 3/8 means . . . that it takes three turns and eight leaves to arrive at the next leaf in corresponding position.

SOME Fibonacci sequences of common plants are as follows . . .

Toyon 2/5
Coast Live Oak 2/5
Madrone 2/5
Calif. Bay or Laurel 2/5
Manzanita 2/5
Mustard 2/5
Poplar 2/5 in the buds or leaves
Willow 3/8
Holly 2/5
Weeping Willow 3/8

Sugar Pine . . . Sets of spirals on the cones show 8 spirals in one direction and 5 in the other. The interlacing spirals show Fibonacci counts between successive junctions.

Coulter Pine . . . a very large cone showing a 13/8 pattern.

Bishop Pine . . . a 13/8 pattern in the cone.

Yellow Pine . . . cones show 8/5, 8/13, and 13/5 patterns using various spirals. The leaf scars have a 5/3 pattern.

Digger Pine . . . 8/5 and 13/8 patterns in cones.

Monterey Pine . . . 3 spirals go from any one point . . . an 8/5 pattern and a pattern of 13/5 and one 13/8 pattern.

Jeffrey Pine . . . 8/5, 13/5, 13/8 patterns in cones (not same cone).

Coast Redwood . . . the cone shows a 3/5 pattern. Leaves appear to be flat in two opposite directions. At the point of attachment is a 3/8. This is easier to see where branch and leaflets are larger.

Sierra Redwood . . . Spikes on larger branches show a 2/5 pattern.

White Fir . . . 5/3 pattern in the leaves.

Investigate the seed head of a Sunflower . . . of a pineapple . . . you will be amazed with the Fibonacci findings!

Bird Observations

(Observe wild birds from a window feed tray—tame ones in a cage.)

1. Use a mirror on the feed tray. Is there any reaction? Compare reactions in the fall with in the spring! Try a triple mirror such as used on vanity trays.

2. Color the food used on the feeding tray with vegetable dyes. Is there any color preference? Do different birds of the same 'family' react the same way to the same colored food? Do birds from different families react differently and if so, how?? How could you determine whether different birds can distinguish all the colors that we do?? Place rubber, plastic or mounted insects near the bird but protected from being touched by the bird. Note the reactions and record your observations. What are your conclusions based on your findings???
3. Place near the tray or cage a stuffed or a model of a bird. Vary your offerings with smaller and larger and similar appearing 'birds'. Record each different situation you set up and your observations. Alter some of your 'controls' and try to arrive at conclusions to explain the behavior.
4. How do birds respond to motion?? Place a thin board balanced on a narrow edge so that it behaves like a teeter. Adjust it so that it teeters readily. Observe how the bird solves his hunger problem and how long it takes him to figure out a solution.
5. Use a tape recorder to record the song or talk of the bird. Try to use a voice-actuated mike to eliminate long pauses. Observe the reactions carefully as you play back to the bird his own voice. Also try playing to a bird the song or talk of another bird of the same kind, then of a bird of a different type. Record these observations and make comparisons. What are your explanations? Try to find out what terms the psychologists use for the kinds of behavior you saw! How do you think some people react to these same or similar situations??? Explain.

EFFECTS OF SMOKE ON INSECTS

Animals and equipment

1–glass tube, ½″ to ¾″ diameter, open both ends.
2–one-hole stoppers to fit the tube.
2–short pieces of glass tubing to fit the stoppers.
2–plugs or tape to close off tubing in stoppers.

Housefly, bee, or most any insect larger than tubing diameter.

1. Place insect in tube with 1-hole stoppers at each end. Place tape or plug over one of the stopper holes. Blow cigarette smoke into open-holed stopper.

Observe . . . insects reactions.
Release smoke and enter air.
Observe recovery of insect.

2. Set up tube. Insert 3–4″ tubing in one stopper. Insert this stopper in one end of tube. Place insect and enough cotton to ⅔rds fill the tube. Place other stopper at remaining end of

tube. As you blow smoke into the tube, withdraw the smoke from other end.

Observe . . . similarities and differences in these reactions and those previously.

Investigate . . . How long can the same insect be repeatedly subjected to these exposures to smoke???

Does immunity or increased susceptibility seem to build up??

Variations. . . . Use, instead of cigarette smoke, your own breath. Try smoke from rags, from paper. Place in the tube 3–5 of the same type of insects and note variations in individual reactions. Do the same with 3–5 insects of different types. Can you draw any *conclusions*??

INSECT OBSERVATIONS

Equipment: a wooden box, about 2 feet square with 2″ sides.
removable glass top (or small mesh screening with supports)
sand—enough to cover bottom to depth of 1 inch.
small air holes in sides (unless screening is used)
do not paint or stain the box—leave it natural.

1. Gather a variety of insects (8–10) found within a few feet of each other.

2. Gently place the insects all in the same corner of the sand box.

Observe . . . trails in the sand. How do they differ? Could you identify or match the trail with the insect, if you did not see the insect next time?

Observe . . . Varying methods of locomotion. Can you draw on paper the *order* or sequence of leg movements of each insect? Do the same varieties always use the same order of leg motion?

3. Alter the environment. Place a branch in the center of sand box.

Observe . . . which, if any, insects prefer its shade. Do any insects eat away on the branch? on only certain parts? Is it a dead or freshly cut branch? Does the branch have any odor? Does this seem to attract or repel the insects? Can you draw any conclusions?

4. Place about one cupful of coarse sawdust or fine wood shavings in one corner of sand box.

Observe . . . How many and which varieties are still visible after 3 minutes? What does this tell you?

5. Through a straw or tubing blow smoke into the sand box.

Observe . . . any changes in activities. Describe. Lift the glass cover, allowing smoke to escape. After a few minutes, replace the cover. *Observe* . . . any changes in behavior? Discuss.

6. Make a list of *other* alterations to their environment of the sand box. Why should you use same insects for several experiments? Why use different insects each time? Repeat some of the preceding experiments from time to time. Look for consistency of behavior. BE SURE TO RETURN insects to the nature area when finished with your observations. *Research* . . . why does insect behavior have value to man and other living things?

DETERMINING AGE OF PINE TREES

Look at pine trees of different heights.

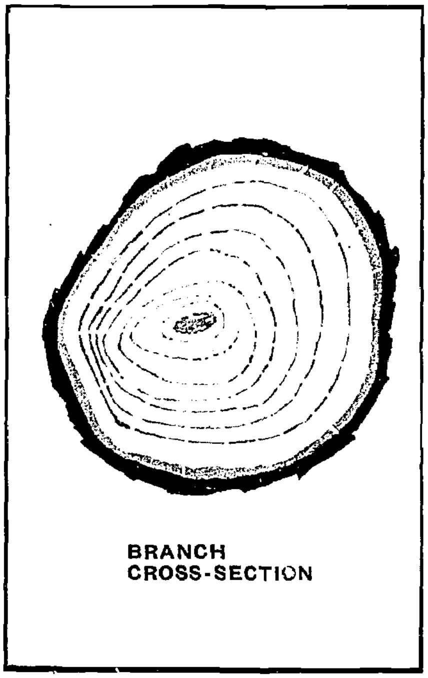
Notice that the branches are in whorls around the trunk.

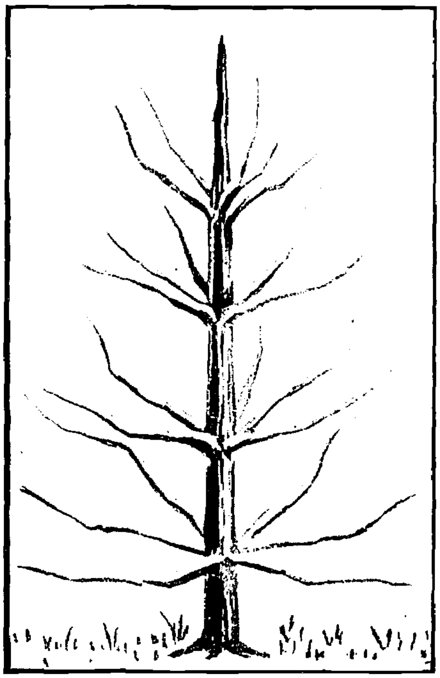
The number of whorls (or branch scars), counting from the ground up, gives the age of the tree.

To check this, cut off a branch near the base of a pine. Count the number of annual rings.

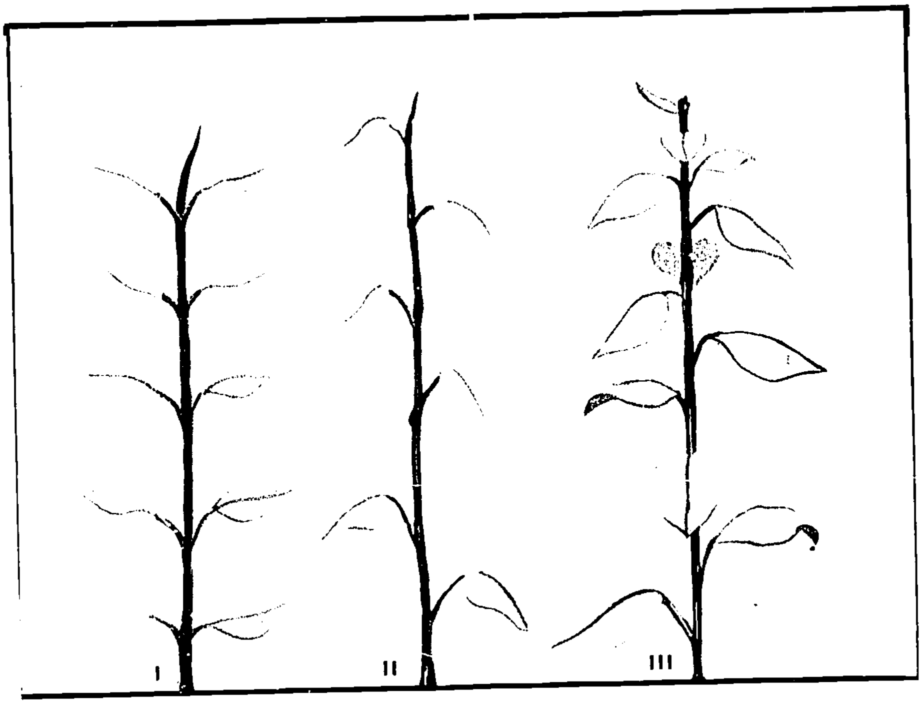
Look for the wide bands (spring wood) and the narrow bands (darker, summer wood) that make up each annual ring.

What might have caused these changes in ring width?





Why does growth seem to be greater in some directions outward from the center? What environmental factors may be indicated from these rings? (sunny side? wind exposure?)

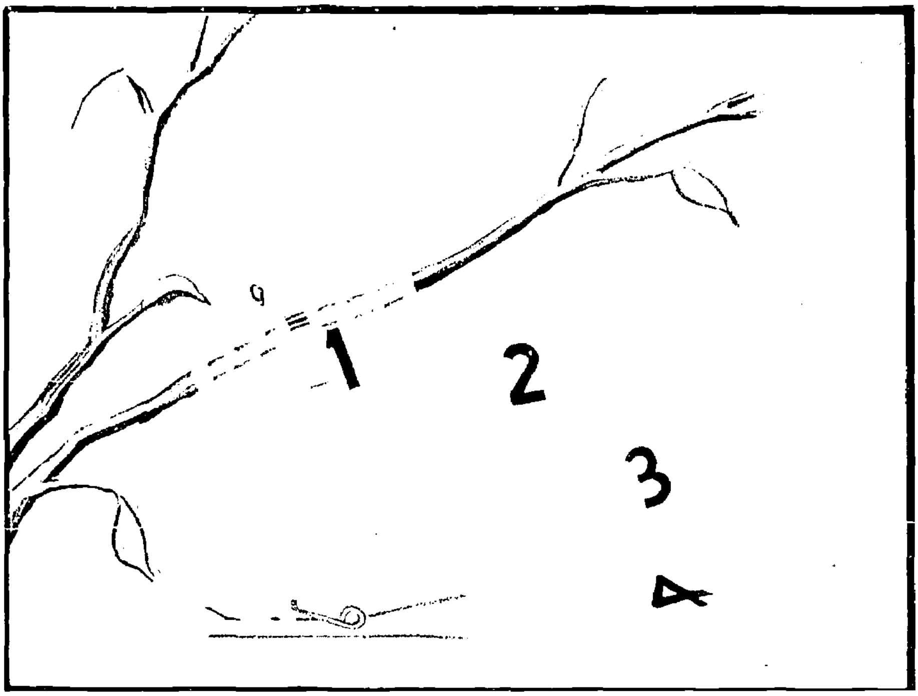


Leaf Patterns

OBSERVATION OF LEAF PATTERNS

Make up a set of 3"x5" or 4"x6" cards, one for each pupil *OR* Draw a model of same on chalkboard and let pupils sketch their own . . .

Leaf Patterns
(alternate pattern)



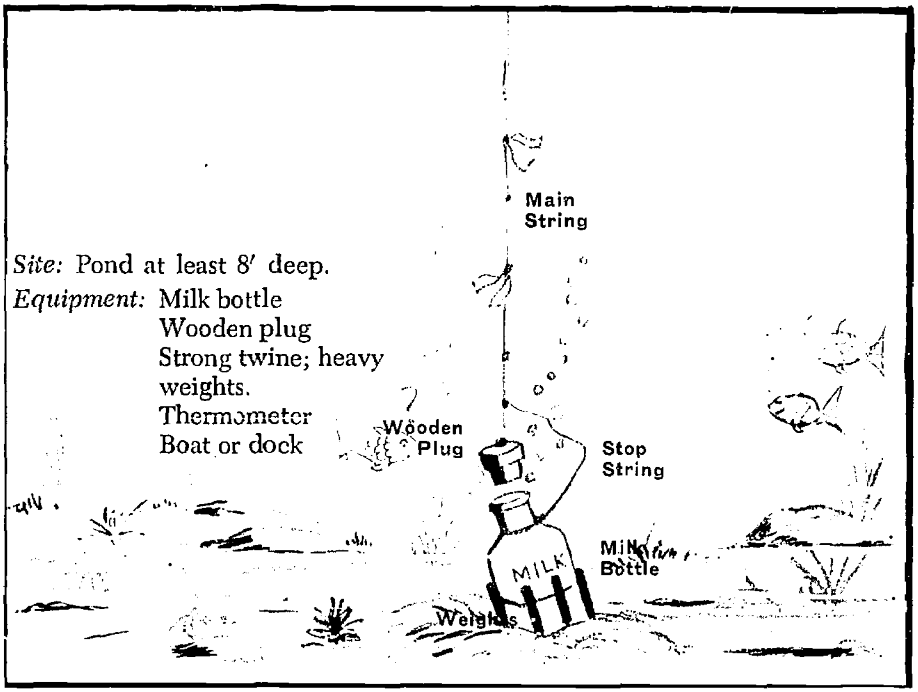
Take 10 3″x5″ white cards. Give each a numeral, one to ten. With a snap-on clothes pin, attach each numbered card to a branch of a shrub or tree . . . and so that the numeral can easily be seen.

Let the children make out an "answer sheet", numbered from 1 to 10. Now, with answer sheet, pencil, and Leaf Pattern Card, have pupils disperse throughout the nature area.

As each pupil comes to a numbered shrub or tree, have his record on his answer sheet a "I", or a "II", or a "III" according to how the leaves seem to him to be formed on the branch (opposite, alternate, or whorled).

After a 'reasonable' period of time, reassemble the children for a discussion and/or evaluation of their findings. On questionable responses, send the group back to that shrub or tree.

Variations: Think up some, using 1–10 numbered cards and different Clue Card. Develop a file of such as you progress.



Site: Pond at least 8′ deep.

Equipment: Milk bottle
Wooden plug
Strong twine; heavy weights.
Thermometer
Boat or dock

VERTICAL TEMPERATURE DIFFERENCES IN BODIES OF WATER

Procedure:

1. Lower bottle until it rests on bottom. Pull out plug by jerking quickly on line. Wait a few minutes after air bubbles stop. Pull up bottle quickly but with smooth motion.
2. Immediately measure temperature of this sample of bottom water. Record temperature.

Compare surface temperature with bottom temperature.

How much difference is there?

Sample other portions of the pond. Compare temps. at bottom and at surface.

Tie knots in the main line to represent one foot distances. At each third knot attach some colored material. Use this depth gauge to record the depths of the bottoms that you sample.

Could you plot a profile of the bottom for a distance of 100′ straight out from shore? On this profile, record your temperature readings at bottom and at surface. Label these readings on profile.

Repeat the above procedures in a stream or river (moving water). How do your results compare for the same depths in the pond?? Why?

Would temperature differences have anything to do with fish, with water plants? How could you find out???

Would your information thus gathered be of help to fishermen?

Would there be any value to taking temp. samplings of water at different depths other than at the bottom? Why?

Measure water temperatures at constant intervals going *across* a stream or river . . . again by going up or downstream. What are your conclusions? Of what value could this information be to others?

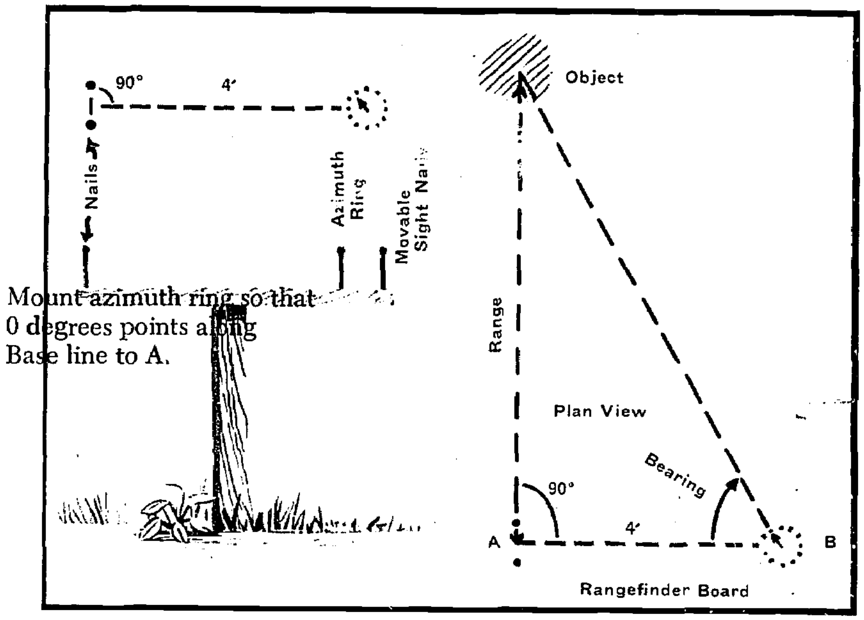
RANGE-FINDING (determining distance by indirect measurement)

Equipment:

1—Range-finder 4' or 6' long, approx. 4" wide, 1" thick.
2—2" headless nails
1—azimuth ring, 3"–4" diameter.
1—sighting bar to center over azimuth ring.
1—tripod or sturdy post.

Procedure:

1. Set up Rangefinder sturdily with left end at A. Rotate horizontally until 2 nail 'sights' on left line up with "0".
2. Clamp board in this position. Do not move Finder again. Walk carefully over to B. Sight along azimuth sight at "0". Record this azimuth bearing.
3. On graph paper, draw to scale the base line (4'), horizontally, near bottom of graph. Label ends A & B.
4. At A, extend a line vertically to top of paper. This is angle BAO.
5. At B, with a protractor, lay off the angle you read on the azimuth scale. This is angle ABO of the diagram above. Extend this line, BO, until it reaches line AO. The intersection locates the Object O. Read up on the graph paper the units distance from A to O. Using your scale, convert this



unit distance to feet. You have now found the distance from A to O by indirect measurement. Can you think of other practical applications of this device?

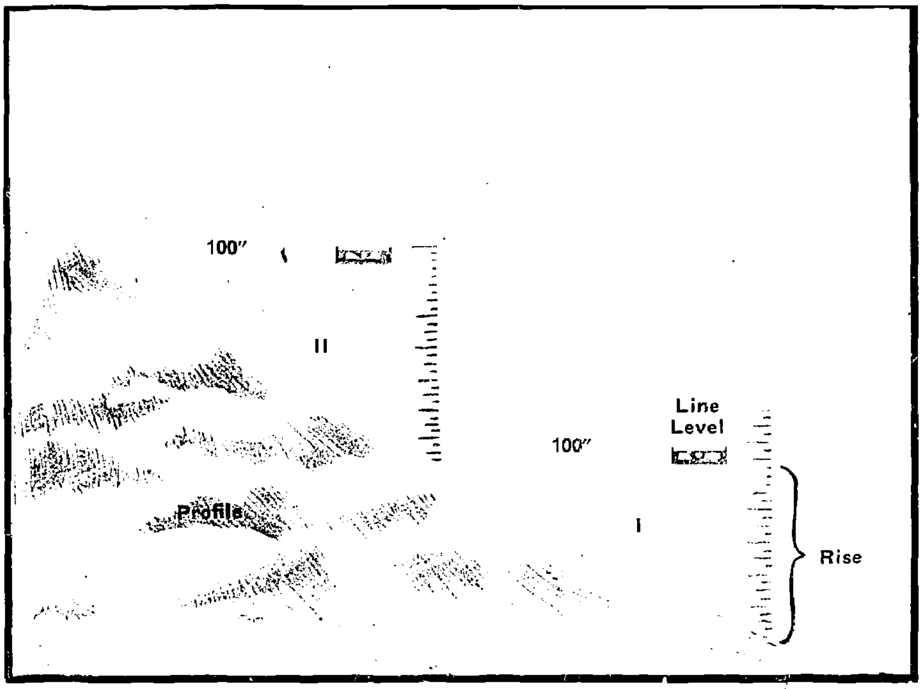
DETERMINATION OF SLOPE

Equipment:

1—wooden stake or rod 100 inches long, approx. 2″ x 2″ or 2″ diameter.
1—carpenter's line level, 2–3″ long.
1—stake, 5′ long, with tape measure attached, reaching from bottom up.

Procedure: Tape the line level to one end of the 100″ stick.

1. Stand at foot of hill or mound. Look uphill in direction the slope is to be determined.
2. Place 100″ stick uphill, with line level end near you. Move this end up or down slowly until stick is level according to bubble.
3. Hold stick steady. Hold measuring stake vertical at line level end of the 100″ stick. Read the height that the level stick is above the ground. This is the amount of rise of the ground surface per 100″ of horizontal distance. Record as a % of slope.
4. Repeat procedure by moving up hill to spot where 100″ stick last rested on the ground. Place vertical measuring stick at this spot and extend 100″ stick on uphill to rest on ground, keeping line level end nearest you and measuring stick. Read rise and record. Several such rise readings should average out the slope of the hill.



SOIL TEMPERATURES

Equipment:

Post-hole digger
Broom handle or 2″ x 2″ stake, 5′ long. Nail a yardstick or tape to one face of stick, O at bottom of stick.
Thermometer

Procedure:

1. Dig a hole 3′–4′ deep at the site to be tested.
2. Lower the thermometer (attached securely to bottom of stick) until it rests on bottom of hole. If this is a *new* hole, leave thermometer in hole for at least one hour. Afterwards, 5–10 minutes will suffice, after conditions have become constant. Note and record the depth of thermometer as read on stick.
3. Quickly pull up the thermometer and take a reading. Record this. Take several readings in each hole. Record them all, including depths of readings.

What differences do you note? Graph your results, using a vertical number line. On left scale of number line, record the depths, using a constant scale. On the right side of this number line, use a different scale for the range of temperature readings you recorded. Post the temp. readings to correspond with the depths.

Did the temperature changes turn out about as you predicted?

Are you surprised at some of your findings? Why?

Can you find any relationship between these temperatures and the nearby plant life? How would earthworms, insects, moles make use of these temperature differences?

Variation: Use same thermometer stick to determine temperatures at different depths in SNOW. Do you see why birds and animals think the snow is a blanket??

DEVELOPING THE SENSE OF SMELL

1. Take a small group of students onto a trail. Let them smell their way along. Have them describe the smells.
2. Crush a leaf. Have students try to describe the smell.
3. Gather a handful of moist earth from beneath the leafmold or duff. Have children describe the smell. Let them tell you how it makes them feel. What does it make them think about?
4. Break open a fruit. Have children tell you about its smell.
5. Have in the classroom a Smell Box, wherein there is something they can smell but not see. Let them describe the smell and try to identify the source. See if they can match the smell with a plant or object in the school nature area.

DEVELOPING THE SENSE OF TOUCH

1. Have the children walk along a trail in the outdoor nature area. Stop them, tell them to close their eyes, then continue to